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DNA 5640F

# CONCEPTS FOR PROTRACTED WAR

Boeing Aerospace Company  
P.O. Box 3999  
Seattle, Washington 98124

1 December 1980

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SEP 04 1992  
S A D

Final Report for Period 22 February 1980—1 December 1980

CONTRACT No. DNA 001-80-C-0163

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Washington, D. C. 20305

92-15318



276/98

92 6 11 047

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JPL Case No. 86-121

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DNA 5640F	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE AND SUBTITLE CONCEPTS FOR PROTRACTED WAR	5. TYPE OF REPORT & PERIOD COVERED Final Report for Period 22 Feb 80-1 Dec 80	
6. AUTHOR Joseph W. Russel		7. PERFORMING ORG. REPORT NUMBER D180-26139-1
8. PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Aerospace Company P.O. Box 3999 Seattle, Washington 98124		9. CONTRACT OR GRANT NUMBER(s) DNA 001-80-C-0163
10. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		11. PROGRAM ELEMENT PROJECT TASK AREA & WORK UNIT NUMBERS Subtask W99QAXOA101-05
12. DISTRIBUTION STATEMENT (of this Report)		13. REPORT DATE 1 December 1980
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. NUMBER OF PAGES 312
16. SECURITY CLASSIFICATION (of this Report)		17. SECURITY CLASSIFICATION (of this Report)
18. SUPPLEMENTARY NOTES This work sponsored by the Defense Nuclear Agency under RDT&E R:ISS Code B3G4080464 W99QAXOA10105 H25900.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Protracted War Counter Military Attack Survival Endurance Space Dependence C3I Logistics Strategic Forces Post Attack Missions Nuclear Exchange Nuclear War		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This study is a preliminary investigation into the concepts and requirements of a protracted war which would continue after a counter military nuclear exchange between the United States and the Soviet Union. The exchange envisioned for this study represents a near "worst case" for a military only attack, but stops short of escalating into direct industrial and population attacks. It seeks to gain insights into the many different		

DD FORM 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued)

ways that military forces can be stressed and the post-attack environments with which they must cope.

Given the conditions emanating from such an attack, the study next seeks to define, in broad terms, the protracted war missions for which U.S. military forces will be needed.

Finally, it proposes some solutions to enhance U.S. capabilities to overcome some of the specific deficiencies noted during the course of the study. This later effort, while quite substantial, does not attempt to address a comprehensive approach to a structured plan for preparing for the requirements of protracted war.

Accession For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
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Availability Codes	
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A-1	

UNANNOUNCED

DTIC QUALITY INSPECTED 1

[REDACTED]

PREFACE

[REDACTED]

This investigation was accomplished by the Systems Analysis group of the Boeing Aerospace Company. Mr. Joseph W. Russel was the principal investigator. Technical coordination was provided by Heinz Leistner. Contributions to the report and to the development of conceptual ideas were provided by a number of staff members of the Systems Analysis and Concept Formulations groups, particularly:

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L. R. White



Conversion factors for U.S. customary  
to metric (SI) units of measurement.

To Convert From	To	Multiply By
angstrom	meters (m)	1.000 000 X E -10
atmosphere (normal)	kilo pascal (kPa)	1 013 25 X E +2
bar	kilo pascal (kPa)	1.000 000 X E +2
barn	meter <sup>2</sup> (m <sup>2</sup> )	1.000 000 X E -28
British thermal unit (thermochemical)	joule (J)	1.054 350 X E +3
calorie (thermochemical)	joule (J)	4.184 000
cal (thermochemical)/cm <sup>2</sup>	mega joule/m <sup>2</sup> (MJ/m <sup>2</sup> )	4.184 000 X E -2
curie	giga becquerel (GBq)	3.700 000 X E +1
degree (angle)	radian (rad)	1.745 329 X E -2
degree Fahrenheit	degree kelvin (K)	$T_K = (T_F + 459.67)/1.8$
electron volt	joule (J)	1.602 19 X E -19
erg	joule (J)	1.000 000 X E -7
erg/second	watt (W)	1.000 000 X E -7
foot	meter (m)	3.048 000 X E -1
foot-pound-force	joule (J)	1.355 818
gallon (U.S. liquid)	meter <sup>3</sup> (m <sup>3</sup> )	3.785 412 X E -3
inch	meter (m)	2.540 000 X E -2
jerk	joule (J)	1.000 000 X E +9
joule/kilogram (J/kg) (radiation dose absorbed)	Gray (Gy)	1.000 000
kilotons	terajoules	4.183
kip (1000 lbf)	newton (N)	4.448 222 X E +3
kip/inch <sup>2</sup> (ksi)	kilo pascal (kPa)	6.894 757 X E +3
kip	newton-second/m <sup>2</sup> (N-s/m <sup>2</sup> )	1.000 000 X E +2
micron	meter (m)	1.000 000 X E -6
mil	meter (m)	2.540 000 X E -5
mile (international)	meter (m)	1.609 344 X E +3
ounce	kilogram (kg)	2.834 952 X E -2
pound-force (lbf)	newton (N)	4.448 222
pound-force/inch	newton-meter (N-m)	1.129 848 X E -1
pound-force/inch	newton/meter (N/m)	1.751 269 X E +2
pound-force/foot <sup>2</sup>	kilo pascal (kPa)	4.788 026 X E -2
pound-force/inch <sup>2</sup> (psi)	kilo pascal (kPa)	6.894 757
pound-mass (lbm)	kilogram (kg)	4.535 924 X E -1
pound-mass-foot <sup>2</sup> (moment of inertia)	kilogram-meter <sup>2</sup> (kg-m <sup>2</sup> )	4.214 011 X E -2
pound-mass/foot <sup>3</sup>	kilogram/meter <sup>3</sup> (kg/m <sup>3</sup> )	1.601 846 X E +1
rad (radiation dose absorbed)	*Gray (Gy)	1.000 000 X E -2
roentgen	coulomb/kilogram (C/kg)	2.579 760 X E -4
shake	second (s)	1.000 000 X E -8
slug	kilogram (kg)	1.459 390 X E +1
torr (mm Hg, 0°C)	kilo pascal (kPa)	1.333 22 X E -1

\*The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.

\*\*The Gray (Gy) is the SI unit of absorbed radiation.

A more complete listing of conversions may be found in "Metric Practice Guide E 380-74," American Society for Testing and Materials

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INTRODUCTION

1-1 SCOPE

This study is a preliminary investigation into the concepts and requirements of a protracted war which could continue after a counter-military nuclear exchange between the United States and the Soviet Union. The exchange envisioned for this study represents a near "worst case" for a military only attack, but stops short of escalating into direct industrial and population attacks. As such, it represents only one of a spectrum of "limited" nuclear attacks which could lead to protracted warfare. However, it is a scenario we believe of particular value to emphasize because it seeks to gain insights into the many different ways that military forces can be stressed and the post-attack environments with which they must cope.

Given the conditions emanating from such an attack, the study next seeks to define, in broad terms, the protracted war missions for which U.S. military forces will be needed.

Finally, it proposes some solutions to enhance U.S. capabilities to overcome some of the specific deficiencies noted during the course of the study. This latter effort, while quite substantial, does not attempt to address a comprehensive approach to a structured plan for preparing for the requirements of protracted warfare.

Since the concept of protracted nuclear warfare is markedly different from U.S. strategic concepts of the past several decades, a brief review of strategic policies and global perceptions of the two superpowers during this time will be useful in understanding the developing concept which this study addresses.

1-2 SOVIET INTENTIONS AND U.S. PERSPECTIVE

In the 1960's both the Soviet Union and the United States accepted "peaceful coexistence" as the replacement for the "cold war" of the 1950's. However, "peaceful coexistence" has had significantly different meanings to

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the two nations. To the Soviet Union, it has meant a relationship in which each superpower would refrain from directly confronting the other. But at the same time the Soviets also have seen it as an opportunity to exploit an inherently unstable international system in order to advance Soviet power and influence. U.S. policymakers and opinion leaders have held that, not only would each superpower refrain from directly threatening the other but, of even greater importance, they both had a common interest in maintaining the stability of the international system. Thus, in the U.S. view, neither would seek to undermine the stability of the international system by trying to change the balance of world power and influence between the two competing superpowers.

The Soviets see peaceful coexistence as "a special form of the class struggle in the international area"<sup>(1)\*</sup> rather than "the end of the struggle between the two world systems."<sup>(2)</sup> Even more explicit is the Soviet view that "the strategic purpose of peaceful coexistence is to insure favorable conditions for the world-wide victory of socialism"<sup>(3)</sup>, and a "complete and final victory of Communism on a world scale."<sup>(4)</sup> Brezhnev gave the Soviet rationale for such a view in December 1972: "because the world outlook and class aims of socialism and capitalism are opposed and irreconcilable."<sup>(5)</sup> The Soviets interpret peaceful coexistence to mean the actions of Western capitalist countries are circumscribed while the interests of world communism are advanced.

### 1-3 SOVIET VIEWS OF THE "CORRELATION OF FORCES"

It is apparent from their statements that the Soviet leadership has convinced itself that the U.S. does not now have the power to do other than seek peaceful relations with the Soviet Union on whatever conditions it can get. Soviet writings make it clear that they believe that the U.S. has lost or can no longer deal with the USSR on the basis of "its notorious 'from-a-position-of-strength' policy and...the policy of ignoring the realities of the modern world."<sup>(6)</sup> As a result Soviet spokesmen have reiterated the theme that the U.S. was forced to negotiate from a position of weakness.

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\*Numbers in parentheses refer to list of references.

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"The strategic course of U.S. policy is now changing before our very eyes from 'pax Americana'...to a definite form of necessity for peaceful coexistence. But we must clearly understand that this change is a forced one and that it is precisely the power—the social, economic and, ultimately, military power—of the Soviet Union and the socialist countries that is compelling American ruling circles to engage in an agonizing reappraisal of values."(7)

This has been the espoused position of the Soviet Union ever since President Nixon signed the SALT I agreement. The "correlation of world forces" has shifted, according to Moscow, in favor of the Soviet Union. This shift, Moscow contends, has been brought about by ever-increasing Soviet power and the decline of the United States.

"Recent international events have...shown that the change in the balance of forces is not some kind of an abstract formula but a tangible reality that is making the imperialist powers adapt to the new situation and is making it possible to bring about major changes in the international arena."(8)

In June 1974 Brezhnev stated: "Having evaluated the overall balance of forces in the world, we arrived at the conclusion a few years ago that there was a real possibility for bringing about a fundamental change in the international situation."(9)

#### 1-4 U.S. DECLARATORY POLICIES

U.S. declaratory policy as it relates to the deterrence of nuclear warfare has received increased scrutiny as the Soviet Union approached and then achieved parity with the United States in strategic offense capability. In the view of many, the Soviet capability has gone well beyond parity into a Soviet superiority.

Lately, there have been numerous articles written and much discussion on whether or not our declaratory policy matched our targeting doctrine, or whether our strategic nuclear resources were sufficient to implement our strategic doctrine. On the other hand, there has been equal, if not more, discussion as to whether our strategic capabilities were in excess of that to implement our declaratory policy. In many of these discussions, it is not clear what declaratory policy is being referenced. We have had a number of



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declaratory policies over the last twenty years with more policy statements being made in recent years.

The following strategic doctrines and their operative time periods have been annunciated over the last twenty five years:

- |   |              |
|---|--------------|
| . Massive Retaliation                         | 1950's       |
| . Assured Destruction/Damage Limiting (AD/DL) | 1960's       |
| . Mutual Assured Destruction (MAD)            | Late 1960's  |
| . Strategic Sufficiency (SUFF)                | Early 1970's |
| . Essential Equivalence (EE)                  | Mid 1970's   |
| . Rough Equivalence (RE)                      | Mid 1970's   |
| . Countervailing Strategy                     | Late 1970's  |

A review of these principal policy statements and a comparison with our strategic implementation capability that existed at the time the policy was announced may give some insight into why there were so many policy changes over the last two decades. Figure 1-1 shows the relative capabilities (expressed in deployed throw weight) of the two powers' strategic forces to date with an extrapolation for the next six years. It is apparent that restatement of U.S. strategic policy has coincided with the growing imbalance in U.S./U.S.S.R. strategic capabilities rather than as a result of U.S. force developments.

#### Mutual Assured Destruction (MAD)

A sizeable group of Americans believe that deterrence of nuclear war is the basic concept underlying the Mutual Assured Destruction (MAD) doctrine—i.e., make the potential consequences of a nuclear exchange so intolerable neither side would dare start a war. This view holds that U.S. and Soviet nuclear weapons would be targeted on each other's population centers and major industries. The United States would always retain sufficient nuclear military strength to deal the Soviet Union a catastrophic blow even after taking a Soviet first strike. Each side would know that to initiate a nuclear exchange would result in devastating retaliation. With assured annihilation as table stakes, it would be suicidal for either side to strike first. (Not usually discussed in this philosophy is the fact that the retaliator is also committing suicide.)

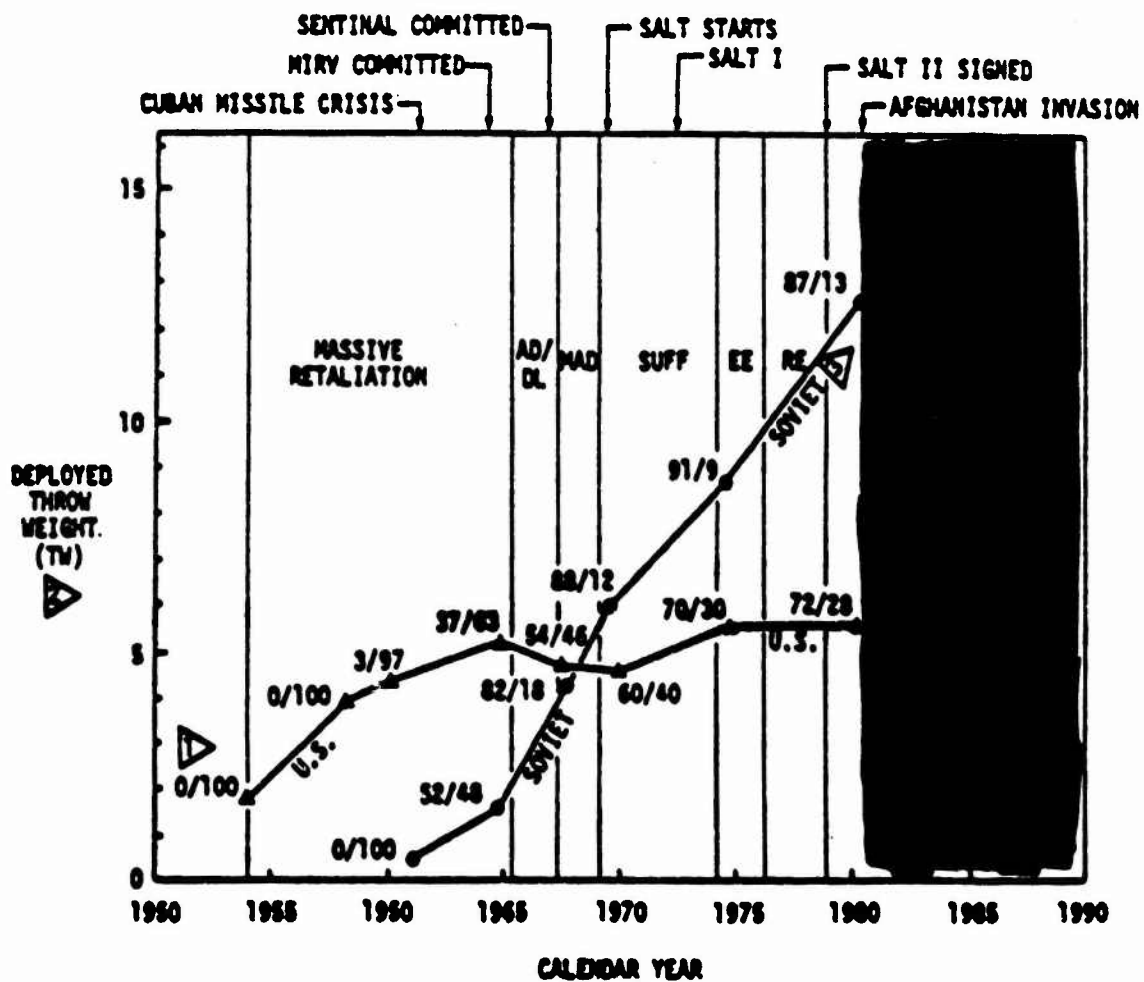


Figure 1-1. U.S./U.S.S.R. strategic capabilities.

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To be practicable MAD has some provisos: first, neither side would build first strike weapons capable of destroying the other side's retaliatory weapons, and second neither would protect its cities with effective active and passive defenses, thereby limiting unacceptable damage. Not to adhere to both provisos would tend to make nuclear war an acceptable option. (The tolerance of Soviet air defenses by those espousing this doctrine is usually explained on the assumption these defenses are useless against ballistic missiles and are therefore futile.)

#### 1-5 SOVIET WAR-FIGHTING, WAR-WINNING DOCTRINE

The Soviet military leaders, as revealed in their writings, have never accepted the necessity for mutual vulnerability. They do not use the concept of deterrence, not in a military sense. Most likely the Soviets are sincere when claiming they want to avoid nuclear war, but just as sincerely they make it clear that if a superpower nuclear war should occur, they intend to fight and ultimately win. Thus, Soviet military writings stress a "war-fighting, war-winning" doctrine that has been adapted to Clausewitz's dictum that war is an extension of politics. From affirming Moscow's support of "liberation" wars, to rejecting the ideas that superpower nuclear war is unthinkable or that such a war can have no winner, Soviet military doctrine consistently supports the correlation between war and policy. A key point in this doctrine is that despite revolutionary increases in the destructive power of weapons, Moscow continues to view war as an instrument of policy:

"The premise of Marxism-Leninism on war as a continuation of policy by military means remains true in an atmosphere of fundamental changes in military matters. The attempt of certain bourgeois ideologists to prove that nuclear war moves beyond the control of policy, ceases to be an instrument of policy, and does not constitute its continuation is theoretically incorrect and politically reactionary....The description of the correlation between war and policy is fully valid for the use of weapons of mass destruction. Far from leading to a lessening of the role of policy in waging war, the tremendous might of the means of destruction leads to the raising of that role. After all, immeasurably more effective means of struggle are now at the direct disposal of state power."(10)

[REDACTED]

This view is in direct contradiction to the view held by some Western theorists that the catastrophic destructiveness of nuclear weapons makes such weapons less effective as an instrument of policy. Furthermore, Soviet war doctrine calls for victory not deterrence, preemption not retaliation, and superiority in weapons not "rough equivalence," thus acknowledging the "extraordinarily important role" military might plays in assuring world peace (on Soviet terms). This doctrine has five related elements: preemption, quantitative superiority, counterforce and C<sup>3</sup> targeting, combined arms operations to supplement nuclear strikes, and defense.(11)

Soviet strategic doctrine stresses the value of surprise in war and the decisiveness of a nuclear first strike capability. The Soviets have concluded that in any future war, nuclear weapons will be the deciding factor. From this they have deduced that the side that strikes first with nuclear weapons will have a significant advantage and, in fact, will win the war.

#### 1-6 STRATEGIC ARMS LIMITATION NEGOTIATIONS

For most of two decades the U.S. has been negotiating with the U.S.S.R. in an attempt to establish the MAD doctrine as the basis for nuclear arms limitations. The hope has been to stabilize nuclear weapons development at a point where neither country possesses a disarming first strike capability. Once parity has been reached, no new nuclear weapons would need to be developed by either side. At least that has been the guiding theory behind SALT.

While the Soviets have been talking one thing, they have been doing another. Over the last decade Soviet strategic forces have surpassed those of the U.S. in quantity, accuracy and effectiveness. Some people believe the U.S. has allowed this imbalance in nuclear forces to grow to such an extent as to invalidate the doctrine of deterrence, the cornerstone of U.S. strategic policy.

It is evident the Soviets are striving not for nuclear weapons parity but for superiority. Parity in nuclear weapons is unacceptable to the Soviets because it runs counter to their Marxist-Leninist view that no

[REDACTED]

lasting stability is possible until the downfall of capitalism and the final world-wide victory of Soviet-led socialism. If nuclear war should occur, the Soviets contend it will mean the destruction of capitalism and the establishment of global socialism patterned after the Soviet system. The Soviets refuse to accept parity for the sake of mutual vulnerability because to do so would be to conform to a western strategic concept they interpret as another tactic to perpetuate the world capitalist system.

"Peaceful coexistence" may be a favorite expression, seemingly compatible with the concepts behind nuclear weapons parity, but it is just a Soviet expedient meant to weaken western resolve and hasten the overthrow of capitalism. There is no status quo the Soviets will be satisfied with short of all-out victory.

#### 1-7 INCREASING SOVIET ADVENTURISM

The Brezhnev doctrine, as enunciated in 1968 to justify the Soviet invasion of Czechoslovakia, proclaims the right of the U.S.S.R. to intervene militarily in any socialist country where so-called "socialist gains" are threatened. The Soviet invasion of Afghanistan in December 1979 reminded the rest of the world that Moscow still considers the Brezhnev doctrine valid and in force. Interestingly, justification in Soviet journals for the intervention in Afghanistan significantly broadened the scope of Soviet interventionist policy.

"In addition to the Soviet Union's obligations to render aid under international law there existed other, equally weighty obligations. In rendering military assistance to friendly revolutionary Afghanistan, the Soviet Union proceeded from the fact that to leave the Afghan revolution in the lurch, prey to the counterrevolution, would be to ignore our internationalist duty as Communists. The Soviet Union was prompted in its action by the dictates of its revolutionary conscience, it proceeded from the behests of Lenin, who wrote back in 1915: the socialist state would if need be help the oppressed classes of other countries 'using even armed force against the exploiting classes and their states.'"(12)

[REDACTED]

Now it appears that this doctrine might well be used against Poland. The Poles have demanded and to a limited extent been given "freedoms" that are significantly greater than those available to the Russians and other captive nations...therefore posing a threat to the tight Soviet control now in being.

This far-reaching interpretation takes on added significance when considered in light of recent Soviet "reinterpretations" of the takeover by force by the Soviet Union in 1940 of the three Baltic countries of Latvia, Lithuania, and Estonia. The new version of Soviet history now portrays these actions by the Red Army as laudable examples of "peaceful revolution," thereby legitimizing an increasingly "external role" for Soviet military forces.(13)

#### 1-6 EMERGING THREAT

Soviet doctrine is not empty rhetoric; it is being matched by Soviet capabilities. The Soviets have slowly and methodically developed a capability to attack the U.S. strategic nuclear forces while still holding most of our society as hostages to keep the U.S. from making good its threat of launching a retaliatory city strike. In human terms the potential consequences are staggering. A properly designed Soviet attack against U.S. forces would result in holding 144 million Americans hostage to influence the actions of U.S. leaders. An imprudent response could trigger the slaughter of these Americans in a Soviet third strike against U.S. cities.

The Soviet's force posture, their push for weapons superiority rather than weapons equivalence, indicates clearly that the U.S.S.R. is preparing for the possibility of nuclear war. Should Moscow perceive that a crisis situation could evolve into a nuclear war, the Soviets may very possibly strike preemptively.

While the Soviets claim they would never launch an initial nuclear attack, and while it is possible the Soviet build-up of nuclear weapons is intended solely to exert influence on Western Europe, it is prudent to consider a preemptive strike against the U.S. to be one of the prime Soviet military options. No matter how a war could start, the Soviet Union might



[REDACTED]

be confident its nuclear and conventional forces combined with its civil defense efforts would allow it to fight longer and more effectively and therefore come out victorious.

In the face of the huge and menacing unused forces that the Soviets would hold after an attack on U.S. forces, the emerging requirement is one of being able to control (or even better to dominate) escalation and hold a useable reserve force adequate to deter follow-on attacks against American cities. A requirement of escalation control is enduring survivability, a capability not yet designed into U.S. strategic systems and their associated Command and Control. This does not imply, however, that U.S. strategic forces used in a responsive strike against the Soviet military could not or would not be able to inflict widespread and significant damage. Such an exchange could lead to a condition where neither side had achieved a clear military victory nor had been defeated so thoroughly that it could not or would not continue to fight for a protracted period of time.

[REDACTED]

#### 1-9 IMPLICATIONS

[REDACTED]

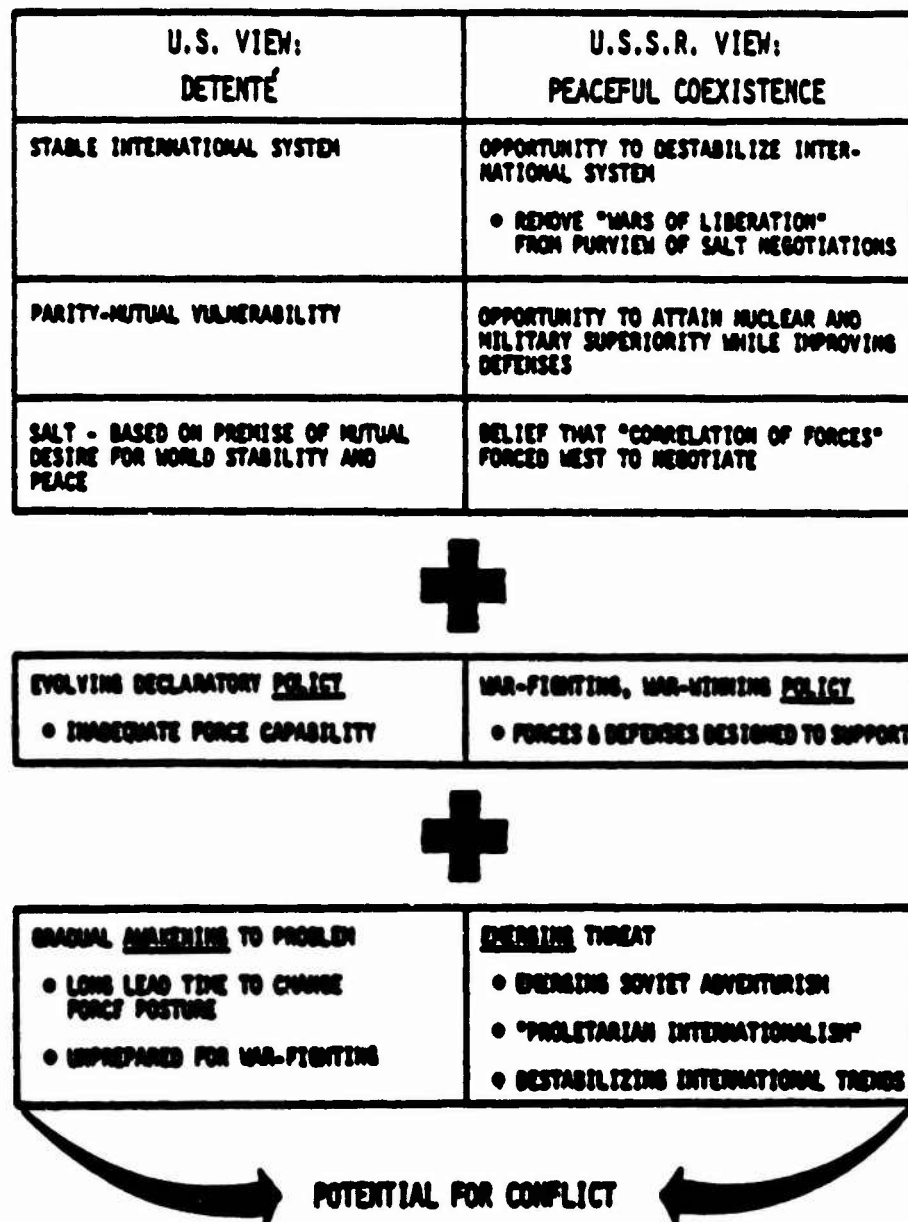


Figure 1-2. U.S./U.S.S.R. conflicting perspective and objectives.

[REDACTED]

[REDACTED]

Thus, at a time when Soviet geo-political successes and shifting perspective of the "correlation of forces" are encouraging Moscow into increasing adventurism, [REDACTED]

[REDACTED] The possibility of confrontation (graphically depicted in Figure 1-2) which could lead to nuclear war has never been greater. This possibility, coupled with Soviet strategy to use their weapons to destroy American weapons and defeat U.S. military forces, makes the study of protracted war, its environment, missions and military needs, of utmost importance to U.S. force planners and designers.

[REDACTED]

## EXECUTIVE SUMMARY

[REDACTED]

### Background

Substantial improvements in Soviet strategic weapons capabilities over the last decade have given Soviet forces a significant and improving first strike capability. This capability coupled with the Soviet war-fighting/war-winning philosophy has prompted this study of the likely consequences of a protracted nuclear war. This study envisions such a war as one which starts with a massive countermilitary nuclear weapon exchange between the U.S. and the U.S.S.R. in which neither side achieves a decisive outcome. An examination of the post-attack period is made to conceptualize the environment that would characterize this period and to describe how such a war probably would evolve into a protracted war. From this analysis the principal military missions U.S. forces would be required to undertake are explored in general terms. Concluding this study are recommendations for improvements in selected systems that would enhance the adequacy of present or planned U.S. forces to execute missions to continue to achieve favorable conflict resolution during a protracted war.

The circumstances that could lead to protracted war could arise from the divergent perceptions of the balance of world power that have long marked U.S.-U.S.S.R. relations. "Detente" to U.S. leaders has meant mutual restraint in affairs affecting global stability. To Soviet leaders "peaceful coexistence" and the lessening of superpower tensions has meant an opportunity to exploit an inherently unstable international system in order to advance Soviet power and influence. Moscow believes that the U.S. no longer has the will or power to deal with the Soviet Union in any other way but on Soviet terms. Soviet doctrine stresses the idea that military superiority can be used coercively. The threat facing the U.S. is that U.S.S.R. initiatives attempting to exploit this perceived advantage will lead to conflicts which could generate circumstances that convince Soviet leaders a first strike against the U.S. is in the best interests of the U.S.S.R. Reinforcing this danger is the Soviet belief that a nuclear war can be fought and won.

[REDACTED]

Given the many uncertainties inherent in an examination of such a complex subject as protracted war, this study can only hope to be a gross approximation. However, because the threat to the United States is so real, analysis along these lines provides valuable and needed insights.

#### War Initiation and Soviet Objectives

Rather than postulating a geopolitical scenario for war initiation, two concepts of how a central nuclear war begins are considered. The first is a central nuclear exchange which grows out of a theater conflict. The second is a war initiated simultaneously worldwide by a Soviet first strike against U.S. military capabilities. A 1984 initiation date was used for the damage calculations in this study. In both cases it is assumed that whenever feasible the Soviets will employ surprise and deception to maximize the effect of these strikes.

It is postulated that the two primary Soviet objectives would be to destroy U.S. military capabilities to wage war and limit damage to the Soviet Union. Coercion plays a dominant role in the second objective. It is unrealistic for the Soviets to assume they could destroy all of the U.S. strategic weapons in a first strike. Therefore, it is postulated the Soviets will attempt to hold U.S. cities hostage, under threat of an annihilating city attack, as a means to deter the U.S. from launching a retaliatory attack on Soviet population centers. For reasons of national self interest, each side limits its strikes to military targets. In such a war, the retention of large reserves of strategic weapons would be a paramount concern of both sides. The attack analyzed in this study was structured to destroy U.S. military forces while leaving the Soviets a large reserve with which to attempt to dominate escalation.

#### Post Attack Environment

The protracted war environment after a major nuclear exchange will depend on the Soviet attack objectives and the structure of the attack. For purposes of this study, the post-attack conditions that were considered most influential were:

- [REDACTED]
- (1) the effectiveness of the Soviet military attack measured in fatalities and damage,
  - (2) the effects of nuclear fallout,
  - (3) the loss of Command, Control, Communications and Intelligence information that both sides will incur,
  - (4) the need for an enduring deterrent force to prevent city attacks plus other reasons why national leaders will tend to reduce the post-exchange rate of nuclear weapons expenditures, and
  - (5) societal considerations (acknowledged but not examined in this study), such as national will and population support.

### Attack Effectiveness

Damage from a Soviet attack on U.S. forces and facilities as they are currently postured is shown to be overwhelming. Among active duty military personnel, rough estimates indicate there would be as many as 1.2 million fatalities worldwide. Destruction of principal military facilities and fixed bases would be on the order of 66% to 88% overall, with losses of bases having major forces or functions being almost total. This effectively removes the U.S. capability to project forces. While not examined in detail in this study, damage to the Soviet military from a U.S. countermilitary response strike will also be extensive.

[REDACTED]

### Fallout Environment

Radioactive fallout, resulting primarily from surface burst weapons used in attacks on hard targets, will influence the conduct of a protracted war significantly, particularly during the first two weeks. A high percentage of the U.S. population, in order to survive or avoid serious illness, will have to seek out and remain in the best available radiation shelters for one to two weeks. Effective measures to protect against fallout are fairly



[REDACTED]

easy to implement but are not generally known. The extent to which the requirement to use protective shelters will initially immobilize large areas of both nations is a significant factor of the protracted war environment.

#### Loss of C<sup>3</sup>I and Space Assets

#### Follow-on Use of Strategic Weapons

National leaders' perceptions (or misperceptions) of enemy strength and fears of overcommitting scarce or irreplaceable nuclear weapons assets will tend to reduce the rate of nuclear weapon expenditure during the protracted war period. These perceptions, plus the overriding need (for reasons of national self interest) to maintain a deterrent against escalation to urban-industrial attacks, will inhibit weapon expenditure. Only when an opponent sees an opportunity for a favorable exchange rate against his opponent's reserve nuclear forces are large salvo-style attacks likely to occur. Instead, the war probably will become one of continuing attrition against the opponent's military forces.



## Protracted War Military Missions

Fundamentally, U.S. military missions would remain unchanged in a protracted war. Only in effort, emphasis, timing, and perhaps operational techniques would there be differences. Resolving the conflict in favor of the U.S. would be the overriding objective. First priority are the basic military missions essential to national survival. These are the maintenance of forces for strategic strike capability and for protection of the homeland. Next is the need to reconstitute the CONUS logistical base, probably the most demanding task identified. This is followed closely by the restoration of C<sup>3</sup>I capabilities. Last, the ability to reinforce the theater forces and to project force to critical areas are essential. The ability to achieve early successes in these efforts, both for the U.S. and its allies, appears especially critical.

### Personnel

The loss of experienced U.S. military personnel in the early phases of a nuclear war would seriously jeopardize the successful completion of post-attack missions. A large cadre of trained military personnel around which the recovery and reconstitution efforts could be organized is essential. Unfortunately, a critically high percentage of active duty military personnel are now vulnerable to the effects of a nuclear attack, even with early warning. Priority programs aimed at increasing the survival rates of U.S. military personnel should be implemented as soon as possible.

Heavy attrition of active duty military forces in the initial phases of a nuclear war will place extreme demands on reserve units. National Guard and Individual Ready Reserves should be prepared to function effectively in a protracted war environment. The existing dispersion of their armories and encampments enhances their survival. A major program aimed at preparing Ready Reserves for the advent of protracted nuclear war is needed.

## Enduring Weapon Systems

To be able to fight a protracted nuclear war requires not only the (albeit rudimentary) weapon systems but the ability to protect those weapons and other critical assets from nuclear attacks. Essential to the decision by U.S. leaders to conduct a protracted war is their knowledge of enduring availability of strategic forces. Two major components were considered in this study. The manned bomber is a versatile instrument both for strategic strikes and reconnaissance. ICBM's are an effective means for delivery of incisive attacks on targets developing during the protracted war in the opponent's homeland or other critical regions.

This study considers several concepts for retainable ICBM basing: (1) deep basing, (2) multiple protective structures, and (3) combinations of hardening and dispersal with mobility. From various investigations it can be concluded that deep-based facilities can provide, on a cost effective basis, the survivability and endurance required for retainable ICBM forces.

Concepts for enduring bombers must recognize that extensive damage to normal bomber bases will occur. The concepts must anticipate the need for great flexibility in terms of availability of runways, weapons, parts, fuel and crews. Short field capable bomber concepts and their anticipated contribution to the enhancement of U.S. capability in protracted war are described in this report.

## Enduring Space Capability

In a protracted war replenishable satellites, that are autonomous spacecraft with little or no dependence on ground control, can be used for a variety of functions. One suggested concept for initial attack missions is to have satellites that can be launched at the onset of a central exchange so they will be able to observe missile launches, detect NUDET and perform transattack communications. As a result, the basing for launchers for these missions need not be survivable. The "launch on strategic indicators" - "launch on warning" approach requires launchers to be on alert and to have quick reaction time.

[REDACTED]

Survivable basing is required, however, for the more general and enduring missions such as reconnaissance and replacement of failed satellites.

The additional missile stages needed to achieve higher satellite velocities require either longer boosters than those presently accommodated in submarines and MX shelters or small satellites. A deep underground basing system such as MESA could accommodate these space boosters. To determine the best approach (in terms of cost/performance) for MESA based space boosters and/or rudimentary satellite designs, further study is needed.

#### Modifications of Operations and Facilities

The U.S. military's protracted war-fighting capability would be enhanced if the following conceptual approaches were developed into systems: short field bombers, deep-based strategic reserve forces, and replaceable, autonomous satellites. Such operational concepts as dispersed shelters for military personnel and for base reconstitution units should also be implemented.

War-fighting concepts will have to be developed which respond to the conditions expected to prevail during a protracted war. There are some modifications to current U.S. military operations and facilities which can be implemented with minimal costs that will provide increased capabilities to fight protracted war. Other changes such as those needed for strategic C<sup>3</sup>I and logistic systems in order to sustain operations for a protracted war after a nuclear exchange will be both lengthy and costly.

#### Insights Gained

Despite the complexity and magnitude of the subject of protracted war and the numerous uncertainties inherent in the assumptions and estimates on which this study is based, a number of insights become apparent. These insights are highlighted below:

[REDACTED]

o There will be a tremendous need for trained, in-place military personnel.

o [REDACTED] It is clear that provision for survival of military personnel is as important as equipment survival. Improving the survivability of U.S. military personnel probably has the highest cost-effective potential of any of the measures studied.

o [REDACTED]

o U.S. mobilization and force-projection capabilities are highly dependent upon an existing training base and logistical capabilities.

[REDACTED]

o Both the United States and the Soviet Union have placed heavy dependence on the use of space for Command, Control, Communications and Intelligence collection and dissemination. This dependence is increasing. Because of the unique military value of space, should war occur, space will certainly not remain a sanctuary. If conflict occurs in space, its nature would change markedly during protracted warfare.

- With the onset of central nuclear exchanges, the nature of space warfare will shift from attacks in space to attacks on ground-based support equipment.

- With the almost immediate destruction of ground-based space facilities in the first phase of a central nuclear exchange, reconstituted space satellites will be relatively free from attack for an extended period after this central exchange.

[REDACTED]

- To be useable after a central nuclear exchange, new spaced-based systems must have requirements and characteristics significantly different from those now in use.

o Many factors will impact both sides — the loss of C<sup>3</sup>I and the attendant capability to assess the effectiveness of the attack; the immobilizing fall-out environment for the first week or two after the central exchange; the need for a deterrent force coupled with the inclination for national leaders to hoard their remaining nuclear assets; and a number of societal and other considerations. All of these factors will tend to slow the pace and prolong the period of conflict.

o Systems which can perform missions autonomously, particularly with respect to reconnaissance, appear better suited for protracted warfare. Hence, bomber systems, if designed for survivability and endurance (including their supporting systems and weapons), appear particularly suited to protracted warfare. This will require aircraft characteristics, basing systems and methods of operation which are substantially different than those now in use.

### Further Studies

From this study of protracted nuclear war, a number of areas are identified as worthy of future study. In strategic weapons systems, conceptual designs need to be developed for short-runway, or even off-runway, strategic bombers. Ballistic missile basing concepts should be developed to assure the survivability of such weapons. For conventional forces approaches to survival need to be examined that include dispersed storage of critical assets and the sheltering of military personnel. Concepts for the survival or reconstitution from civilian sources of the logistics system should be developed. Concepts for C<sup>3</sup>I capabilities, including space-based systems, need to be developed and evaluated for reestablishment of communication nodes, command posts, and sensor systems. Replenishable and autonomous space systems should be developed. There are many other new systems which could be developed for effectiveness in a protracted war.

[REDACTED]

The subject of protracted nuclear war is so broad and interwoven that it would be useful to undertake an effort which makes a first attempt at structuring an integrated approach to the postural changes needed. Such an effort should consider all aspects of the problem: personnel, weapon systems, supporting systems, logistic base and C<sup>3</sup>I. It should also define the extent, feasibility, priority, cost and timing that are envisioned for these changes. No quick, easy or inexpensive solution will be found. But if a steady and integrated approach is followed over the next decade, the resultant posture will undoubtedly be one which can create sufficient uncertainty in attack outcome that Soviet leaders will be deterred not only from undertaking such an attack but also from threatening to do so.

[REDACTED]

## SECTION 2

[REDACTED]

### APPROACH

The purpose of this study is to examine concepts for the conduct of protracted warfare. It addresses itself to developing better insights into three fundamental questions:

1. After a major nuclear exchange, what would the environment for protracted warfare be like?
2. What missions would be required of U.S. forces?
3. What candidate weapon systems and supporting systems or changes to existing systems would better enable the U.S. to carry out these missions?

In attempting to gain insights which can provide answers to these questions, we recognize the uncertainties and inaccuracies inherent in any approach. There is no historical precedent for a war of the magnitude being considered. Environmental conditions which will exist can only be estimated with rough and multiple extrapolations from single weapon tests which in themselves have large uncertainties. Uncertainties pervade all facets of this effort (e.g. how will future wars be fought?). Yet the threat of such a war is a real one, and insights are needed despite the numerous uncertainties.

In addition to the uncertainties, the magnitude of the elements and forces which must be considered is also staggering. The compilation of highly accurate data bases for this study could, in itself, consume greater resources than those allocated to this study. With these considerations in mind, we have undertaken this analysis using fairly accurate but gross data bases and reasonable approximations and extrapolations of weapons and force interactions. While existing data would enable more accurate estimates to be made of parts of the analysis, such aggregated results would still contain most of the uncertainties just discussed. Accordingly, the effort to develop detailed and highly refined data bases for those portions of the analysis where it was feasible were considered to be unwarranted.



[REDACTED]

Our efforts were focused on making a realistic (but gross) approximation of what we think the world would look like (from a military forces point of view) after the first major nuclear exchange has occurred. We then postulated the broad missions that the U.S. military forces would be required to perform and a general sense of priority of these missions. From this we have postulated general systems that would be needed to support these missions. This list of general systems then provided the basis for selection of several specific systems where our previous and ongoing work has provided expertise to develop in some depth of conceptual detail.

The magnitude and complexity of the task is such that a single study can only get a glimmer of the strategies, forces, and systems needed to cope with such a catastrophe. At the same time, many postural and system deficiencies are so glaring that even with all the uncertainties and approximations inherent in this analysis it is possible to describe the types of changes, improvements and new systems needed to correct or alleviate these deficiencies.

[REDACTED]

## SECTION 3

### CONCEPTS FOR PROTRACTED WAR

#### 3-1 [REDACTED] INTRODUCTION

[REDACTED] Since this study is an initial effort toward the development of concepts of protracted wars, certain assumptions must be made which are consistent with existence of such a conflict. This investigation begins by asserting that a central nuclear war probably will not be decisive, but that a prolonged period will follow during which conflict resolution will be pursued. The estimated conditions which could be created by massive initial nuclear strikes were developed. From these conditions, concepts for conduct of the ensuing war were developed.

#### 3-2 [REDACTED] SCOPE

[REDACTED] There are as many possible scenarios for how a nuclear war might begin as there are people and time to reflect on the subject. If pursuance of this study had to await the development of a consensus for a war initiation scenario, the study would probably never proceed beyond that point. To limit and focus this investigation, two generalized concepts of war initiation were assumed.

[REDACTED] In the first concept, nuclear intercontinental war between the U.S. and U.S.S.R. is assumed to develop out of the escalation of war in one or more overseas theaters. These initiating theater conflicts are assumed to have led to extensive deployment of U.S. power projection forces and to the gradual escalation to a central nuclear war.

[REDACTED] In the second concept, nuclear intercontinental war between the U.S. and the U.S.S.R. is assumed to start as a result of a surprise Soviet first strike against United States and Allied (if appropriate to the scenario) military forces and facilities worldwide. It is recognized that this concept is not a plausible scenario to many people; however, it does provide a "worst case" from which to measure incentive for surprise, survivability and endurance.

[REDACTED]

[REDACTED] For both concepts it is assumed that the initial central nuclear exchange will be a countermilitary exchange with both sides exhibiting reluctance (for reasons of self-interest and survival) to attack urban-industrial and population targets. It is further assumed that this massive exchange of nuclear weapons will not resolve the conflict, i.e., neither party concedes defeat. Thus, it is possible that "combat operations will continue for the purpose of the final defeat of the enemy in his own territory."<sup>(1)\*</sup> This will probably involve some form of theater war and an attempt to invade the opponent's territory.

### 3-3 [REDACTED] ASSUMPTIONS OF WAR INITIATION AND CONDUCT

[REDACTED] The general assumptions used for the two concepts of war initiation and the conduct of the war after the initial nuclear exchange are described here.

#### [REDACTED] CONCEPT I

[REDACTED] Figure 3-1 illustrates the major elements of activities expected to occur in an intercontinental nuclear war which escalates out of conflicts in one or more overseas theaters. It shows the Persian Gulf and Western Europe theaters as representative areas with the potential for conflict initiation. However, equally valid war initiation scenarios could be developed from the Asian theater, War at Sea or, as a more recent development, War in Space. The general assumption made is that nuclear weapons are first used in the theater after which the war escalates to intercontinental use of nuclear weapons against only the opponent's military forces. The term selected for this step is "failure of Phase I deterrence," which is used to indicate that the nuclear threshold has been breached, but that for reasons of self-interest neither side wants to escalate to urban-industrial or population attacks. The step at which urban-industrial and population attacks are undertaken has been defined as "failure of Phase II deterrence."

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\* Numbers in parentheses refer to list of references.

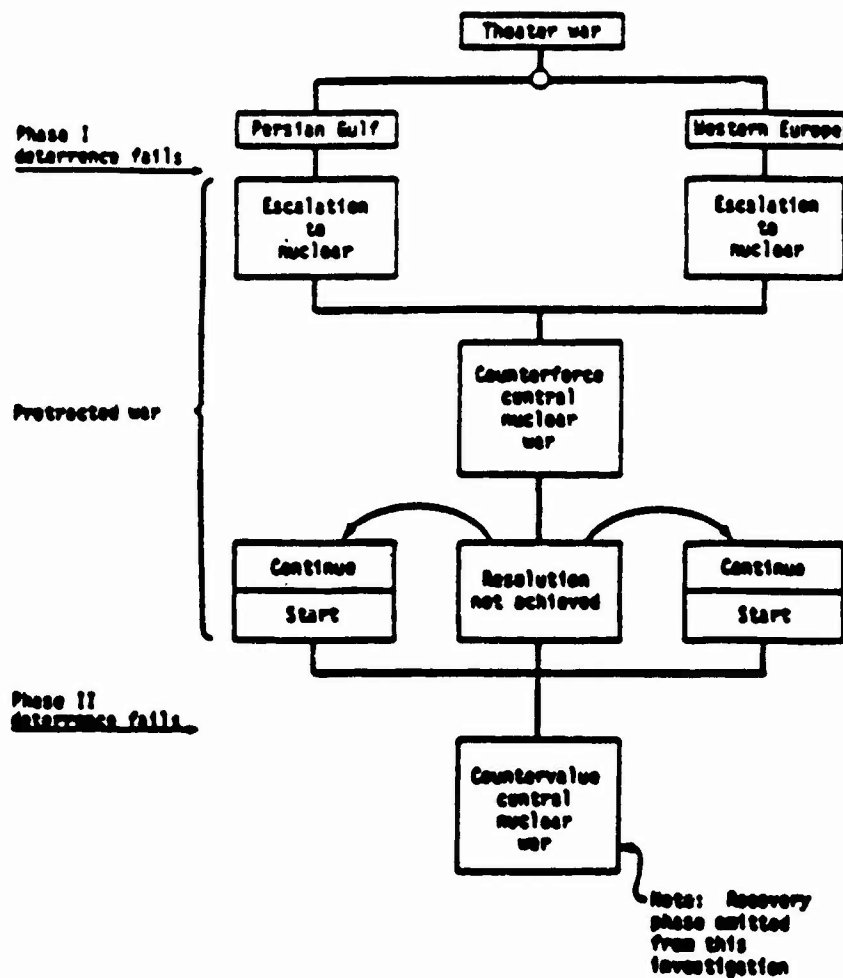


Figure 3-1. Concept I, escalation from theater war.

We did not attempt in this investigation to evaluate protracted warfare after Phase II deterrence has failed. There are several reasons for this. First, to be even remotely valid, the study would have to consider post-attack survival, reorganization and recovery—an effort far beyond the resources available. Second, in the absence of reasonably effective and implementable civil defenses it is very doubtful that after a counter-city attack the United States would have any residual capability to prosecute a protracted war. Whether or not the Soviet Union would have a capability to

[REDACTED]

continue the war depends on assumptions regarding its civil defense effectiveness and post-attack recovery preparations. Post-attack recovery following an urban-industrial nuclear exchange is a separate area of research which was not examined in this study.

[REDACTED] With a non-decisive outcome of the counterforce exchange, the war could develop into a war of attrition against the opponent's military forces and his associated C<sup>3</sup>I but particularly against unused (reserve) strategic nuclear forces. It should be noted that under such conditions forces considered as "strategic nuclear forces" would undoubtedly be much broader than those defined in Strategic Arms Limitations agreements. Indeed, forces originally thought of as limited to local theaters might be found to have significant leverage in the "strategic" outcome of such a conflict. It is this phase of conflict that occurs after an initial large counter-military nuclear exchange and prior to escalation (if any) to urban-industrial and population attacks on which this study is focused.

## [REDACTED] CONCEPT II

Figure 3-2 illustrates the major elements of activities anticipated to occur in a counter-military central nuclear war which is initiated worldwide simultaneously, but more importantly begins with a surprise attack. Here surprise is not intended to mean only a "bolt out of the blue" attack but also includes scenarios where surprise is achieved in crisis situations through the use of deception. Indeed, scenarios which couple deception to a "de-escalating" crisis can provide as much military effectiveness from surprise as can a "bolt out of the blue" attack. While the reasons (e.g., diplomatic conflict or confrontation) which might prompt Soviet leaders to decide that a preemptive strike against the U.S. is in their best interests may be difficult to envision, the circumstances that led to initiation of WWI remind us this possibility should not be ignored. In any event, use of a surprise scenario provides an excellent yardstick from which to measure the relative stability, survivability and endurance of military forces and their various weapon systems.

Phase I  
deterrence fails

Protracted war

Phase II  
deterrence fails

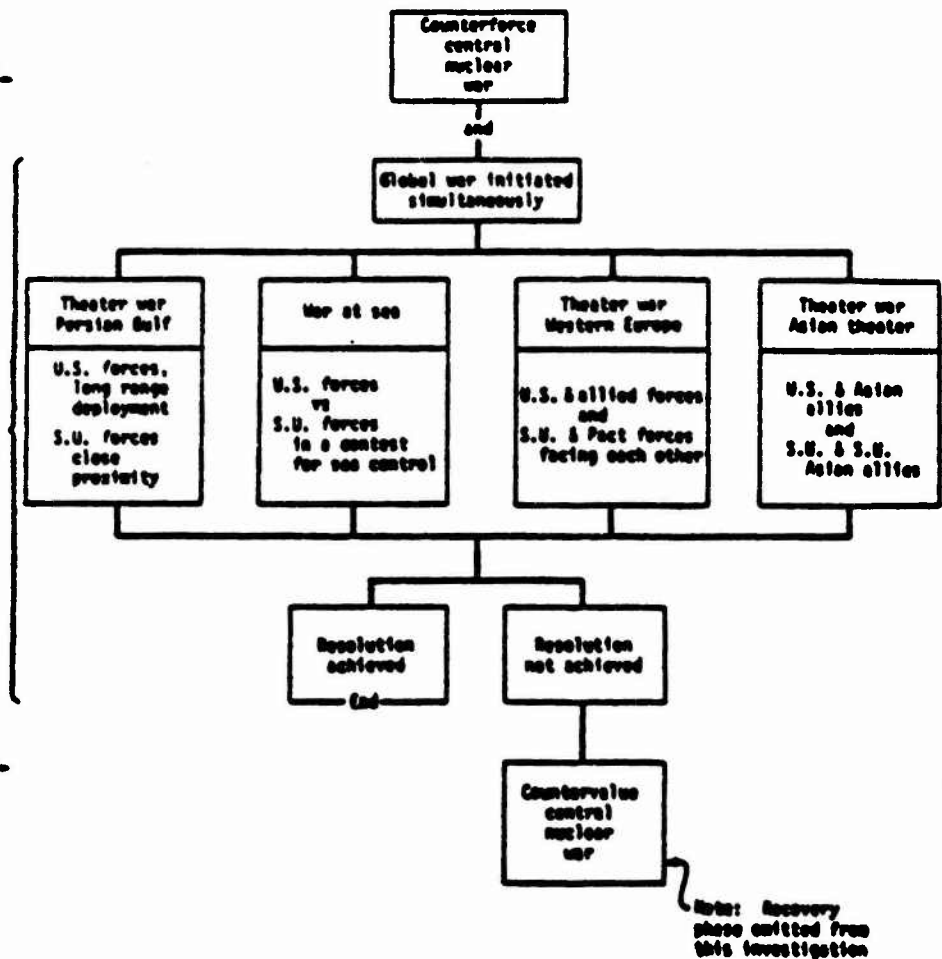


Figure 3-2. Concept II, initiation of world wide surprise attack.

For both of these war initiation concepts we have assumed that the U.S. responds with an attack on all major U.S.S.R. military installations as well as those of the Warsaw Pact. Since our purpose is to examine the environment U.S. forces would face, the missions required of them and ways in which their capabilities for protracted war could be enhanced, a detailed study of the effectiveness of the U.S. attack on the Soviet Union was not performed. There are numerous studies available which show the effectiveness of potential U.S. attack responses on the Soviet Union. No purpose would be served by duplicating those here. It is sufficient to assume that neither side is totally successful in destroying each other's capability to continue some military combat.

3-4 [REDACTED] PROTRACTED WAR ENVIRONMENT

3-4.1 [REDACTED] Central Nuclear Exchange - Attack Effectiveness

[REDACTED] The discussion thus far has developed a basis for a nuclear exchange limited to military targets only. In this section we will amplify that basis to support the specific Soviet attack we analyzed, and will describe the effectiveness of that attack on the U.S. target system.

[REDACTED] The protracted war environment will be dominated by the impact of the nuclear exchange (strategic and theater) on the surviving combat capabilities on both nations, the jarring impact on the populace of follow-on nuclear strikes against residual forces in both homelands, the fear of escalation to assaults on the urban areas, and the difficulties of sustaining support to the theater of operations. The assault against the military structure would leave both nations sorely wounded, but capable of continuing the war until one force is utterly defeated in the field or a truce is accepted politically. The fighting would be intensive but probably at levels far below the pre-exchange capability. In this section we will examine the effectiveness of the Soviet attack and discuss what military strength will survive to fight.

3-4.1.1 [REDACTED] Soviet Attack Objectives

[REDACTED] The circumstances or provocation which convince Soviet leaders that a surprise or preemptive nuclear attack on the United States is in their best interests will also influence the structure of the attack. The magnitude of their attack theoretically could vary from a quite small attack, one designed to achieve a narrow military objective but much larger political objectives [REDACTED] to a massive attack on all important U.S. urban-industrial and military targets.

[REDACTED] While this spectrum of attacks is possible, many attacks within it would be inconsistent with Soviet doctrine, objectives and capabilities. A massive attack on U.S. urban-industrial targets would certainly provoke a similar response from the United States. Considering the war initiation

[REDACTED]

scenarios just discussed, as well as Soviet doctrine and strategy, we judge the most probable attack to be one with the following Soviet objectives:

- (1) To destroy U.S. capability to wage war;
- (2) To limit damage to the Soviet Union,
  - (a) By destroying U.S. will and capability to respond,
  - (b) By holding a largely surviving U.S. population hostage in order to inhibit U.S. escalation.<sup>(2)</sup>

[REDACTED] In order to emphasize and intensify U.S. leaders' perceptions of a Soviet preemptive attack meant to hold U.S. population hostage, the postulated Soviet attack was limited to strikes within the U.S. at military and C<sup>3</sup>I targets only. We judged that, except for hard targets (e.g., ICBM's, hardened command posts), the Soviets would use air bursts to accomplish their attack objectives while at the same time minimizing population fatalities. We also judged the Soviets would use any means possible to inform us of the scope of their attack (as soon as they decided we could not improve our posture based on this information). Such a Soviet strike, however, could not avoid all cities and still accomplish its military objectives. [REDACTED]

[REDACTED] Although the military value of the greater Washington, D.C. metropolitan area also is crucial, the political value of its total survival is even more important. We assumed it would not be attacked in this strictly military option.

[REDACTED] The Soviet attack also was structured to avoid industries with the exception of nuclear warhead manufacturing. Should the Soviet strategy be successful, it would be to their advantage to keep U.S. industries intact. Should it fail, there is little to be lost by delaying a strike against U.S. industries for several days or even weeks. (This would not be valid if the U.S. had previously made preparations for Industrial Protection.)<sup>(3)</sup>

[REDACTED] One of the Soviet's principal goals in structuring the attack was to leave themselves with a large reserve of strategic weapons which they could use to control and dominate escalation. Such a reserve would also give them ample weapons for continuing strikes against military targets which



[REDACTED]

were either not attacked or not destroyed in the initial strike. Such attacks would be extremely important to the fundamental objective of destroying U.S. capability and will to continue to wage war by responding with attacks on the Soviet Union.

Deleted

[REDACTED] Figure 3-3. Norfolk military complex.

[REDACTED] As part of this effort to maintain a large and dominant strategic reserve, the Soviets would replenish their forces with reloads, with newly manufactured weapons and with bomber weapons which had survived in their

[REDACTED]

hardened storages. These latter weapons (i.e., surviving bombers and their reload weapons) are predicted to play an extremely important role in protracted warfare. This is discussed in more detail in Section 5-2.

[REDACTED] We presume that a nuclear attack on an opponent's homeland creates the potential for escalation into uncontrolled urban-industrial attacks and, therefore, reason that the Soviets would not undertake this risk with anything less than an all-out attack on the United States military establishment worldwide. Accordingly, the baseline attack postulated is a heavy Soviet attack on United States [REDACTED] targets in CONUS and overseas, tempered by restraints to avoid populated areas unless the military value requires attack. We believe that an analysis of this type of attack will provide some new insights into what the post-attack world will look like.

#### 3-4.1.2 [REDACTED] Soviet Attack Structure

[REDACTED] For purposes of analysis we have subdivided the Soviet attack into four component parts:

- o An early arriving SLBM attack on SAC bases to destroy aircraft
- o High altitude EMP attacks
- o ICBM attacks on U.S. hard targets
  - ICBM silos and LCF's; SLBM bases; nuclear storage sites, hardened command posts
- o "Tailored" attacks on other [REDACTED] targets worldwide
  - (Tailored in the sense that ground bursts and collateral damage are avoided when this is consistent with attack objectives.)

[REDACTED]

SLBM Attack on SAC Bases

[REDACTED] In structuring the Soviet attack on U.S. SAC bases we chose not to use a barrage attack of the airspace around the bases, but rather to limit the attack to the bases themselves. This is a very controversial subject and has been analyzed in many ways. Our reasons for this selection follow:

- a. An effective barrage attack requires a fairly large number of Soviet submarines to be prepositioned close to the U.S. coasts. The lead time to accomplish this is significant. Furthermore, we judge that this could not be done without alerting the U.S. of the buildup and the value of surprise (or deception in a crisis) would be lost. Further, the available postural countermeasures the U.S. could make upon warning would detract significantly from the value of such an attack.
- b. Ballistic missile submarines can be reloaded with missiles carried by deployable tenders. Having the maximum number of SLBM's in the reserve force undoubtedly will rank high among the Soviet's priorities. But a build-up of deployed SLBM's off the coasts of the United States could easily result in the U.S. moving attack submarines and other ASW forces to positions from which to destroy the bulk of these ballistic missile subs should an attack on the U.S. begin.
- c. Even though barrage attacks usually are characterized as air bursts at altitudes of 30,000 feet, the potential for extensive ground collateral damage is still quite high, and many would be over major U.S. cities. This could mask the purpose of the attack and might be perceived by U.S. leaders as an escalation to city attacks. Since a principal reason for the limited nature of Soviet attack is to try to control escalation, and thereby limit damage to the Soviet Union, this would be inconsistent with their attack objectives. This consideration might well override the advantage of destroying additional SAC aircraft during flyout from their bases.

- [REDACTED]
- d. An additional factor in their choice of tactics is the strength of Soviet Air Defenses against aircraft. While the Soviets would prefer to destroy SAC aircraft in the U.S., in the context of this attack they might choose to risk some increased military losses through penetration of their air defenses, rather than risk a wrong interpretation of the true nature of their attack.
- [REDACTED]

[REDACTED] High Altitude EMP Attack

[REDACTED] Our attack planning provided [REDACTED] Soviet ICBM weapons to be burst at high altitudes in order to cover all of the United States with an EMP pulse. For lack of information on Soviet high altitude fusing capabilities, we used ICBM weapons. Should the Soviets place a high altitude fuse capability in their SLBM weapons, they could reduce the time of arrival of these high altitude bursts [REDACTED]

[REDACTED] We further estimate that this attack [REDACTED] would be repeated [REDACTED] during the initial twenty-four hours of war to sustain the time over which our strategic communications would be disrupted.

## ICBM Attack on Hard Targets

An effective Soviet counterforce attack must strive to destroy a major portion of U.S. ICBM's. There have been many studies conducted on the effectiveness of ground bursts versus the effectiveness of near-surface bursts for silo attacks. While these studies are not conclusive, a general consensus exists among attack planners that there is a higher confidence of kill using ground bursts. Accordingly, we planned ground bursts against silos, Launch Control Facilities and hardened/buried Command Posts and Nuclear Storage Sites. Other moderately hard targets (e.g., SSBN's in port, field nuclear storage sites) could be adequately targeted with air bursts, hence they were used.

The decision to use ground bursts against hard targets turns out to be the single largest factor in producing collateral civilian fatalities among an unprotected (or unprotectable) population (see Section 3-4.1). However, even if near surface bursts were used instead of ground bursts, the burst heights needed for the overpressures required for target kill would still result in significant fallout. Fatalities would be reduced but would still be extensive unless fallout protection is used.

## "Tailored" Attack on Other Targets

The remainder of military targets, were programmed for attack by the smallest yield available in the Soviet strategic arsenal which could accomplish the attack objectives

All of these weapons were assumed to be air bursts. A number of these targets are overseas. We assume that they were attacked with theater nuclear weapons. The inventory and range of yields of Soviet theater weapons is so large that these targets are more than adequately covered with theater weapons.

In addition, it was assumed that a large-scale attack would be made on military forces in NATO (e.g., nuclear storage sites, airbases, air defense sites, POMCUS\* sites, casernes, logistic and ammunition)

---

\* POMCUS: Prepositioning of materiel configured to unit set.

[REDACTED]

facilities, and field deployed forces) as well as strikes at naval forces at sea. A structured analysis of these types of attacks was not made, other than to ensure that all major U.S. bases and logistic facilities were included in our target lists. Numerous studies of theater nuclear attacks on NATO have been made. These studies show the Soviets have sufficient theater nuclear weapons delivery systems capable of carrying out these strikes without use of strategic systems. This is not intended to imply they would not choose to use strategic weapons (e.g., SS-11's) for theater missions. In fact, in the scenarios discussed, where the Soviets anticipate a return strike against their silos, it would be in their interests to use excess SS-11's in theater roles while preserving their mobile SS-20's and aircraft for follow-on strikes. (However, Figure 3-4, which shows the strategic force strength in terms of equivalent weapons remaining to each side after the exchange, corresponds to use of only theater weapons in theater role strikes. The definition of Equivalent Weapons is provided in Appendix B.)

#### 3-4.1.3 [REDACTED] Strategic Exchange and Weapon Allocation

[REDACTED] A significant element of our ability to conduct a protracted war after a nuclear exchange with the Soviets is the capability of our Strategic Forces to execute meaningful follow-on operations if called upon. Therefore, before examining the military target system attacked by the Soviets, we will briefly examine the exchange itself and the aftermath in terms of surviving forces on both sides.

[REDACTED] Using FOREM (see Appendix A) model results the outcomes of strategic counterforce exchanges 1980 to 1990 are displayed on Figure 3-4 in terms of strategic force strength remaining on each side measured in Equivalent Weapons. The dashed U.S. curve is U.S. remaining strength during the first few hours postexchange, including that bomber strength which must be used or lost. This is non-ALCM bomber capability which is unsuited for attacks on ICBM silos and which, presuming the U.S. is unwilling to escalate to urban-industrial attacks, must either be used against other military targets (OMT) or lost because they are not adequately retainable. Whether or not these bomber forces are used, the U.S. strategic strength a short time after the exchange is that shown by the solid curve.

[REDACTED]

**Deleted**

[REDACTED] **Figure 3-4. Strategic balance after counterforce exchange.**

[REDACTED] A 1984 date was selected for the exchange and damage calculations used in this study. The 1984 interchange results are summarized in Tables 3-1 and 3-2a&b. These numbers are, for the Soviets, as low as we can expect and, for the U.S., as high as we can expect. Less optimized targeting could reduce Soviet losses and the surviving U.S. Strategic Reserve force. Note that while there are weapon system changes over the next decade, the numbers of surviving forces remain about the same. Most of the surviving U.S. weapons are SLBM's. [REDACTED]

[REDACTED] That could make our nuclear threat after the exchange considerably less credible [REDACTED]

[REDACTED]

Table 3-1. Soviet weapon allocation: 1984.

Deleted

[REDACTED] It is significant to consider how few weapons it takes to destroy our major bases and important military facilities. After ensuring that our strategic nuclear forces are heavily attacked, only [REDACTED] additional weapons are needed to attack the structure of other forces needed to fight a protracted war, provide interior security, or defend against invasion. Most of the weapons targeted against the strategic nuclear forces were needed to destroy our missile sites. (There is a further discussion about the concentration of functions into a handful of installations.) The small number of weapons needed to destroy our military bases and the effectiveness of the strikes against our strategic nuclear forces explain the enormous reserve force available to the Soviets.



Table 3-2a. U.S. weapons surviving first strike: 1984  
(generated alert).

1984 Generated Alert

	U.S. Warheads					
	U.E.	Survivors <sup>1</sup>	Allocated Against			Remaining <sup>2</sup>
			Soviet ICBM	Soviet SLBM	Soviet Bomber	
U.S. ICBM	2094	328	189	0	0	139
U.S. SLBM	5256	3995	0	0	513	3484
U.S. Bomber	3100	2934	912 (ALCM)	0	0	2022

- <sup>1</sup> After Soviet First Strike  
<sup>2</sup> After U.S. Retaliation

Table 3-2b. U.S. weapons surviving first strike: 1984  
(surprise).

1984 Surprise Attack

	U.S. Warheads					
	U.E.	Survivors <sup>1</sup>	Allocated Against			Remaining <sup>2</sup>
			Soviet ICBM	Soviet SLBM	Soviet Bomber	
U.S. ICBM	2094	328	260	0	0	68
U.S. SLBM	5256	2944	0	0	513	2431
U.S. Bomber	3100	1064	480 (ALCM)	0	0	584

- <sup>1</sup> After Soviet First Strike  
<sup>2</sup> After U.S. Retaliation

3-4.1.4 Target Systems Analysis

For the purpose of analyzing the impact of the postulated Soviet strike, we initially subdivided the target set into (1) U.S. active military bases including Hawaii and Alaska, (2) logistical support bases in the United States, and (3) overseas U.S. bases. Table 3-3 provides a further subdivision of the active military bases and a general summary of the target numbers. Some of these bases are colocated and could be destroyed effectively by a single nuclear weapon. Others are sufficiently large to require two or more nuclear weapons to achieve a high probability of damage to their military facilities. These variances have been considered in arriving at the total weapon requirement; however, a detailed analysis of individual facilities was not performed.

Table 3-3. Summary of U.S. military and support installations.

ICBM Silos/LCF's	1172
Strategic Offense Bases (SAC, SSBN)	
C <sup>3</sup> I (not colocated with other targets)	
Air Bases	105
Naval Bases	60
Army Bases	56
Logistic Facilities	111
Nuclear Material Production, Fabrication and Storage (other than at military bases)	
U.S. Bases Overseas	<u>100</u>
Total	1710+

In addition to the ICBM silos and launch control facilities, the U.S. based target list consists of about [redacted] facilities or functions at over [redacted] different installations. Most of the targets in this set of [redacted] (65%) are located so they can be attacked fully with an air-burst weapon of any existing Soviet yield without causing significant collateral damage to a large city (population 100,000). About 8% of them could be struck while holding collateral civilian damage and casualties to relatively low levels by using low yield weapons and/or careful ground-zero selection. Attack of the remaining 27% of these targets creates levels of collateral urban damage that could

[REDACTED]

cause the U.S. to misconstrue the true limits of the attack. Hence, their individual military worth versus their potential for triggering uncontrolled escalation would have to be carefully weighed by the Soviet leadership.

[REDACTED] Among the [REDACTED] targets there is a wide range of size and impact on our war-fighting capability. The U.S. has tended to concentrate many functions or large amounts of materiel at a relatively small number of major installations. For example, 84% of U.S. Army ammunition resupply in the CONUS is located at three locations [REDACTED] (Table 3-4). As a result of such concentration about 55% of these [REDACTED] installations are too important to be withheld from a determined military attack. About 20% of this target set is composed of targets which have some collective capacity or potential to support power projection but are not individually significant. The remaining 25% fall in between and would require a case-by-case judgment on the military worth of attacking them versus their potential for masking the nature and objective of the attack by collateral damage. For example, the headquarters of the Army's Tank and Automotive Command is embedded in the metropolitan area of Detroit and was not included in the attack even though it has significant importance and could be a focal point for logistical reorganization and control. We deemed the impact of severely damaging a large segment of Detroit would jeopardize the political goals of the Soviet attack.

[REDACTED] Table 3-4. Army ammunition resupply origins.



Considering the existing (lack of) preparations to withstand a nuclear attack and assuming no significant changes in the near-term, the impact of a Soviet attack on our military seems to be disastrous. Closer examination of the attack aftermath together with the way we normally function offers a few possibilities for recouping some strength and waging a protracted war.

The casualties estimated for the Soviet attack are shown in Table 3-5. The civilian figures are high even though the postulated attack is limited to military targets. Most of the civilian casualties result from fallout coming from the surface-burst strikes on the missile silos. The fallout patterns from those strikes are shown in Figure 3-5. The implications of fallout are discussed in paragraph 3-4.2. The military casualties listed in Table 3-5 may seem to be on the low side. The reason will be explained as we develop this section. An important aspect of the relatively remote location of our missile sites is that over 70% of the nonstrategic installations on the target list (Appendix C) are not affected by lethal fallout levels. Although people at installations within the fatal level contours (13% of the list) must use shelters to avoid serious illness or long-term effects, radiation is not a long-term hazard that interferes with efforts to restore/salvage those bases for more than two or three weeks after the attack.

Table 3-5. Fatalities in millions.

. IN U.S.	
. CIVILIANS	29 <sup>A</sup>
	-- 21 FALLOUT
	-- 8 PROMPT
. MILITARY	0.9 <sup>B</sup>
. OVERSEAS	
. MILITARY	0.3 <sup>B</sup>
A. Includes DOD civilians and dependents at bases	
B. Excludes forces field deployed, airborne, or at sea	

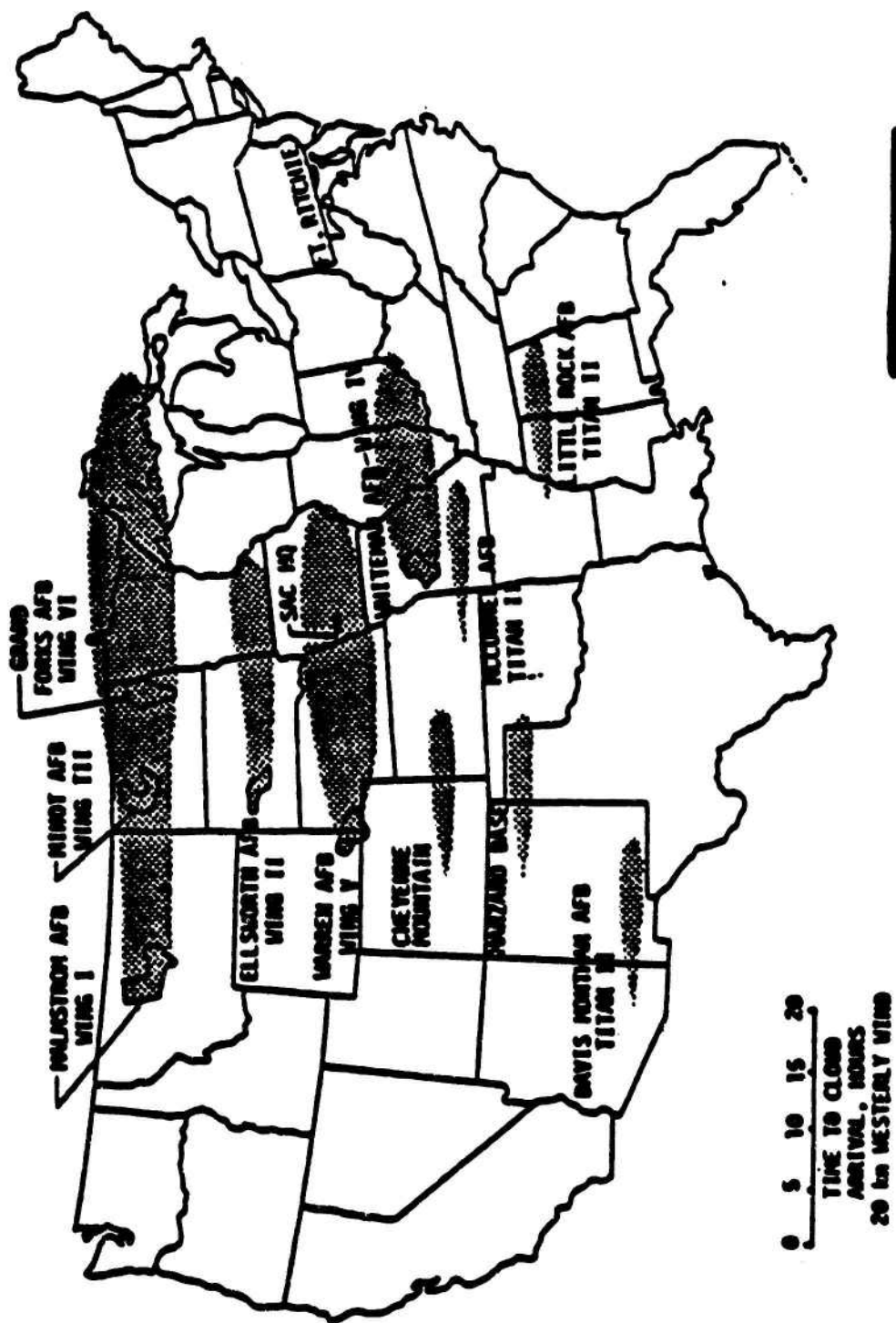


Figure 3-5. Lethal fallout contours.

[REDACTED]

### 3-4.1.5 [REDACTED] Residual Forces

[REDACTED] The possibilities for recouping strength do not include much chance that cantonment areas of major bases for operational forces will be more than marginally useable. Figure 3-6 to 3-8 indicate the damage/fatality factors for the cantonment areas to typical Army, Air Force, Navy and Marine bases. It was noted in the preceding discussion that, except for bases in Norfolk, San Diego, and Charleston, all major bases for forces can be attacked without extensive damage to large populated areas, and they are the ones the Soviets are likely to target with multiple weapons to assure their destruction. In a limited way, the Soviets could take a further hedge against the chance that a major base would escape attack. They could have missiles on standby to be targeted to replace any missiles that were known to have aborted during the launch of their preemptive strikes, provided they can obtain the intelligence data.

[REDACTED] No matter what the planners do, some targets in the attack plan will escape. If we assume that the Soviets scrupulously avoid attacking targets in populated areas, and that operational factors cause 10% of the planned attack to go awry, at least 2/3 of the base structure will be destroyed anyway. We assume that the number of major bases among the surviving set is no more than one or two and that the many others in the 1/3 or less surviving installations are of lesser individual importance. Even if the fraction of bases destroyed is as low as 2/3, the loss is a disaster of major proportions [REDACTED]

[REDACTED]

[REDACTED] Significant portions of the existing, active bases will be destroyed in the postulated attack, including large numbers of trained military and civilian personnel. There is, however, the reality that at any time a portion of the normal base population will be away from the main base on operational or training missions, temporary duty assignments or routine leave. The military casualty figures we project assume that 1/3 of the forces are out of the immediate target area. This survivor portion can be further increased if base commanders disperse their forces thus minimizing concentration.

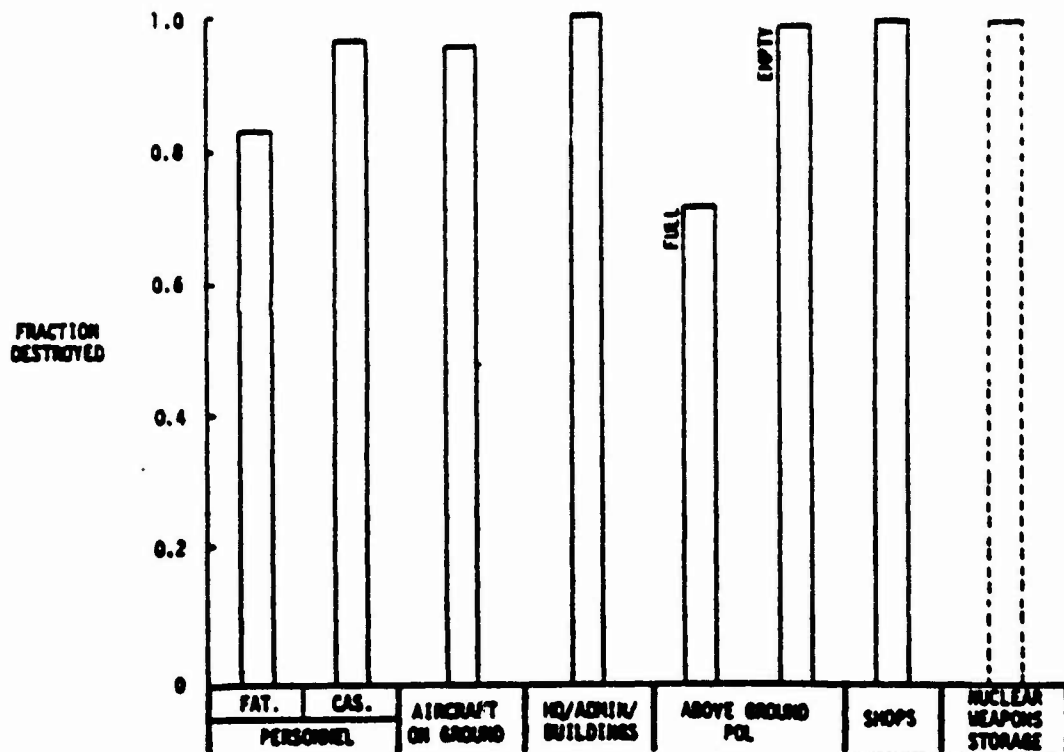


Figure 3-6. Damage at air bases.

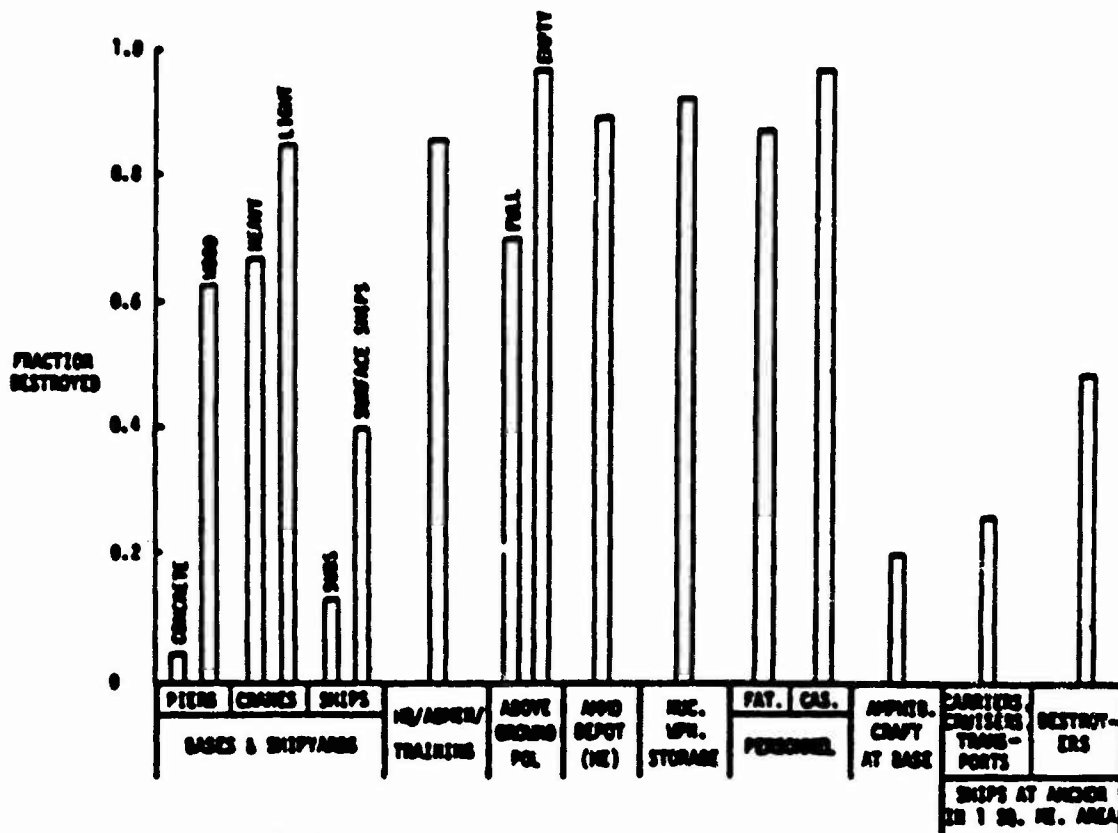
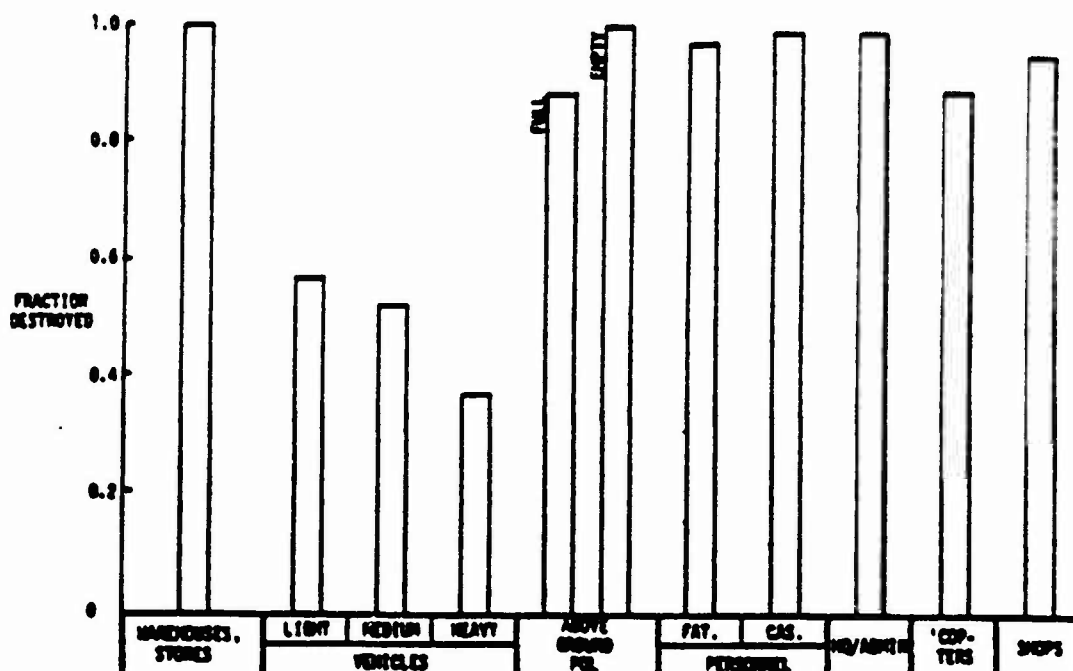


Figure 3-7. Damage at naval bases.



**Figure 3-8. Damage at ground forces installations.**

In addition to the full complements of personnel in some units being away from the ground zero zones of the areas attacked, it is certain that some number of top leaders and middle management at these installations will be away. Some will be with the dispersed forces, some will be in a travel status, some will be on leave, etc. We assumed that 20% of the leaders in troop units and 10% in administrative or logistical installations would be away. The percentages for military staff personnel that are away were less (10% and 8% respectively). One might disagree with the specific numbers we assumed, but the pattern of typical military activity indicates that some numbers must be used to account for those very real and, in terms of our ability to conduct a protracted war, very vital survivors.

Unfortunately, it is not likely that intelligence, communications, and logistical personnel (outside of the dispersed units) will survive in great numbers. Blast, fires, tree blowdown, etc, will wreak havoc—even in



[REDACTED]

the areas some distance away from the ground zeros. However, military materiel is tough. That which is away from the immediate ground zero area(s) is likely to be damaged too, but reparably. Much of it could be salvaged with reasonable effort. Many of the bases could be used as austere operational facilities with selective clean-up. For example, runways could be cleared and used for landing/takeoff; ranges could be used for training by activating reserve units.

[REDACTED] There is a large body of active duty personnel available to reconstitute and fight from places not subject to attack. Thanks to the demands of the volunteer armed force, the services have filled the recruiting commands with top drawer officers and NCO's. They are scattered through the nation. The same kind of find talent is used to fill the ROTC faculties and advisors to the Reserve Components. The fact that the services must put their better people in these kinds of positions is highly beneficial in the context of this study. National Guard and Reserve units provide a vital, largely undamaged resource. They, too, are scattered throughout the nation. While many units may be undermanned, need training and are not fully equipped, they are available resources. Most importantly, they have dedicated, talented leadership. If supplied, trained, and transported to the theater, they will prove to be satisfactory reinforcements. Their weapons and equipment, which is somewhat different from (and older than) that of the active forces, will cause logistical problems. But, the reserve components are the only thing we have to bolster the surviving, active forces, and will be received happily by the theater commander.

[REDACTED] In the event that the nuclear attack rises from a theater war, the installations attacked would be the same. It is the character of the materiel damage and casualties that change. Active forces either will be fighting or in movement to the theater. Their place at the home base will be filled by activating Reserve Component units. The DEFCON level is likely to be higher than in the surprise case. SAC would be on full alert and dispersed. Account was taken in our exchange analysis of the increase in surviving U.S. weapons full alert brings. We chose not to modify the other force losses because even though warned, we believe the 1/3 figure represents the most we could expect to survive unless we do something to provide protection for personnel,

[REDACTED]

materiel, and equipment. Stocks of materiel from logistical facilities will be in movement to the theater providing a pipeline which may escape the attack. Even though a little less materiel will be destroyed, and the level of training of the forces killed will be less, the impact of the attack will be essentially the same. The sameness of the devastation is especially true of intelligence, C<sup>3</sup>, and logistical facilities, organizations, and processing capabilities.

[REDACTED] Thus far this discussion has covered the armed forces as a single entity because there is a considerable similarity in what will happen to them, and what they can do. In this section we discuss some aspects of the attack effectiveness as they pertain uniquely to particular kinds of service installations.

#### [REDACTED] Air Bases (Navy, Air Force, Marine)

[REDACTED] Airbases, regardless of armed service, are essentially the same. They are small, their essential facilities are concentrated beside the runways, and they are soft. Aircraft on the ground are especially vulnerable. The attack will leave the base largely destroyed. However, the runways/taxiways could be cleared and used; it is probable that some POL stocks could be salvaged; and some materiel might be reclaimable. However, communications and flight control gear, operators, supply, and maintenance personnel will be lost with their facilities.

[REDACTED] The destruction at bases is essentially total, but the structure that remains is significant:

- Air units tend to be in the air under normal conditions, so many of them will survive the surprise attack. In the escalation scenario, aircraft would be widely dispersed to airfields unlikely to be attacked, (efforts should be made to stay away from major civilian terminals in order not to draw a military attack there). Therefore, the aircraft survival rate should be somewhat higher.

[REDACTED]

- Reserve Component units are a significant asset. They are scattered throughout the nation (frequently in few numbers at small airfields). They are reasonably self-sufficient logistically, and should function better than the dispersed Active Component force in that respect. We can disperse our tactical aircraft much more readily than the necessary support structure.

- Civilian airfields will provide a haven for airborne aircraft whose bases have been destroyed. Military Airlift Command (which uses many commercial aircraft) may find ready maintenance at those havens, but the tactical aircraft will receive only the minimum support, e.g. POL.

#### Ground Forces Bases (Army and Marine)

[REDACTED] The ground force bases occupy vast acreages. Typically there is a cantonment area that is much larger than the typical Navy or Air Base (because it supports so many more people). Typically it would require a fairly large yield weapon to destroy the cantonment area because of this large size (even though most structures are rather soft).

- Personnel losses in the cantonment area will be extensive. Losses will cut across every discipline, e.g. leaders, staff workers, communicators, troops. But those things such as training or field exercises that would remove large segments of those disciplines from the attack area do not tend to protect key technical people such as supply, maintenance and base support personnel. Their loss will be particularly critical.

- Damage to military equipment will vary considerably. Armored vehicles will not suffer much structural damage from the blast, but critical seals and unions in hydraulic systems could burst and rubber track rollers, tires, etc., could burn or be rendered useless by the blast. However, many would be repairable.

[REDACTED]

- The outlying areas from the central cantonment would suffer from tree blowdown, fires, and range disruption, but could be restored to utility with reasonable, selective effort.

#### Naval Bases

[REDACTED] The Navy bases attacked have some components which are harder to destroy than the average found at Air or Ground Force bases. Also, they are normally part of respectably large cities, hence the necessary attacks on San Diego; the San Francisco Bay area, Norfolk, and Charleston. Some aspects of the hardness can be compensated for by the choice of weapon yield:

- Ships are difficult to sink. The damage to ships in port from the attack will be extensive, especially to the superstructures. Some will suffer hull damage from collisions with piers or other ships. But few will have sunk. Within months, with intensive effort at shipyards, a significant number of ships might be restored to combat.

- Piers and shore facilities will be damaged to varying degrees. Cranes will be collapsed and warehouses knocked down. Much of the equipment and materiel is massive, and should be useable once the rubble is cleared away. Due to the mass and concentration of things at Naval bases, a surprising quantity of useable parts, supplies, and tools are expected to survive.

- Just as the aircraft at Air bases tend to be up on a flight, many ships from Navy bases will be out of the port for operations, training, or shakedown. They too can use the civilian facilities in ports and shipyards when they must put into shore. The routine necessities can undoubtedly be handled there, but any supply or maintenance demands for uniquely military equipment probably will not be satisfied.

[REDACTED]

[REDACTED] Reserve Component ships normally are stationed at major naval bases where the reservists can come to train on them. They are not unique. If left there, they will suffer the same damage as other ships. They are mentioned here to place the damage to them in focus so we can consider peacetime stationing in less attractive targeting areas to avoid losing them unnecessarily.

#### 3-4.1.6 [REDACTED] Attack Summary

[REDACTED] At best, assessing our capabilities after a determined nuclear attack of the military structure in the United States is a nebulous process. We have combined some hard calculations with some practical presumptions to discuss where we are after such an attack. From our work so far we can conclude this:

- At least 2/3 of our more important military installations would be destroyed. If as many as 1/3 survive, the surviving installations are most likely to be in the low priority categories because whatever actions the Soviet planners take to insure a successful attack will be focused on the high value, high priority targets. The certainty of casualties/destruction is greatest for top and middle leadership, supply/maintenance personnel and equipment and C<sup>3</sup>I, both for operations and logistics.

- A severe problem will be the loss of most logistics personnel. Even though much of the materiel they work with may survive the attack in a useable state, the loss of these technical personnel will diminish the value of that materiel.

- Major forces and equipment have been destroyed - 50% or more.

- Military sea and air-lift capabilities have been significantly reduced.

- Surviving strategic systems are (practically) limited to SLBM.

[REDACTED]

[REDACTED] Sizable numbers of Active and Reserve Component people and units will survive. A competent leadership exists therein which can be tapped. The civilian air and sea fleet can be mobilized to support requirements for moving these forces into the protracted war theater. These reserve and surviving resources might be capable of sustaining the war if they can be controlled (organized), based for equipping/training, supplied and maintained.

### 3-4.2 [REDACTED] Fallout Environment

[REDACTED] An element of the protracted war environment which will invade and influence almost every facet of endeavor is nuclear fallout. Even if each opponent makes an effort to limit ground bursts in order to maximize the population held hostage, large amounts of fallout will still be created. This will come principally from attacks on hard targets (Silos, Command Posts, LCFs) where surface bursts will undoubtedly be used to achieve greater effectiveness. In addition, considerable amounts of weapon debris will be carried to high altitudes by the large number of air bursts predicted to be used. There are widely varying views on what the long term effects this quantity of radiation will have on the world. But regardless of the very-long-term effects on human life or the ozone layer, extremely high radiation fields will exist for several weeks, and significant levels will be present for several months. Beyond that low levels will persist which will influence the manner and pace in which many tasks are accomplished. People who received (or who may believe they received) a significant dose of radiation in the period immediately following the attack may be particularly sensitive to additional exposure even at low levels.

#### 3-4.2.1 [REDACTED] Immediate Post-Attack Radiation Environment

[REDACTED] Figure 3-5 (shown earlier) depicts the area in which all people protected by only ordinary houses will accumulate a radiation dose of 450 rads or greater in 14 days. Although defined as the mid-lethal dose, we have assumed all persons who received 450 rads or greater are fatalities. Other assumptions used in the fall-out patterns shown are:

- . People remain indoors for a period of 14 days in an inner room of a frame house with doors and windows shut.
- . A protection factor (PF) of 3 is assumed.
- . An earth roughness factor of .7 was used.
- . An uniform 25 mph wind from the West was used.

As described in paragraph 3-4.1.4 these radiation levels and assumptions would result in an estimated 29 million fatalities among the civilian population. Such fatalities could be reduced significantly by fallout protection. However, as stated earlier, variations in civil defense effectiveness were not made a part of this study. Of equal significance to the conduct of protracted war is the much larger area of the country which will have radiation levels caused by fallout which could become lethal or incapacitating unless protective measures are taken.

Figure 3-9 depicts the area in which people sheltered as just described will accumulate a radiation dose of 200 rads. This is the generally accepted level at which 50% of the people get seriously ill and the first fatalities start. Had these curves been plotted for a radiation dose of 100 rads (frequently used as a one-time emergency exposure limit for military personnel) or even a more conservative 50 rads, then several of the affected areas would merge and cover a greater part of the country. It is acknowledged that significant uncertainties exist in these curves since a double extrapolation was used. Nevertheless, the areas involved are sufficiently large that even a variation of  $\pm 20\%$  would not change the conclusions.

The major conclusion reached is that a large portion of the population (including surviving military personnel) are going to have to take shelter from fallout for about one to two weeks in order to survive or avoid serious illness. This will immobilize significant percentages of the population, particularly surviving military personnel since they will have been preferentially targeted. Not only will this immobilize large numbers of people, it will divert efforts from immediate restoration and reconstitution tasks to those of tracking, measuring, mapping and publishing data on radiation fields.

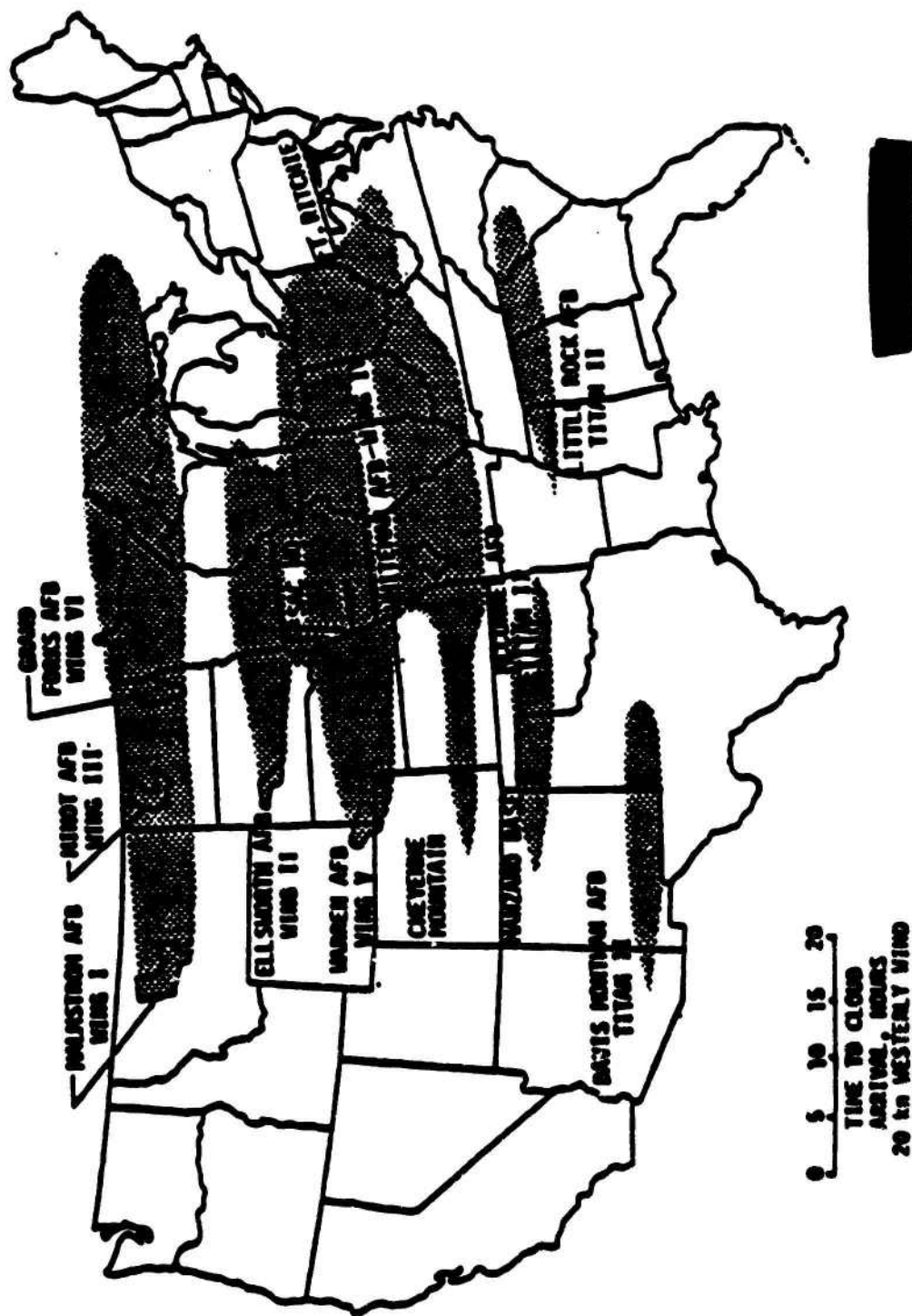


Figure 3-9. Fallout contours—threshold of serious illness.



### 3-4.2.2 [REDACTED] Longer Term Radiation Environments

[REDACTED] For descriptive purposes in this study the fallout (or radiation level) environment was divided into three phases. The first, just described, was classified as life threatening. The second and third phases deal with longer term radiation environments.

[REDACTED] The second phase is envisioned as one of avoidance of specific areas. It could last on the order of one to two months depending on the intensity of initial radiation in the area of concern. An example might be an ICBM silo which was attacked but because of miss distance not destroyed. However, the detonations could still have been close enough to destroy the primary and secondary electrical power systems with the resultant exhaustion of missile emergency battery power. With proper repair by qualified personnel this ICBM could be restored to an operational status. However, the existing radiation fields from the near miss surface bursts could prevent personnel access to the silo for several weeks. This would be even longer for personnel who had already received a high initial dose of radiation.

[REDACTED] The third phase is envisioned as one of dealing with widespread low levels of residual radioactivity which will exist in many parts of the country. The large number of people, particularly poorly prepared ones, who received (or who perceive they received) high initial doses of radiation (many near fatal) may be unwilling to risk further radiation exposure. This will complicate all facets of personnel selection and assignment and greatly aggravate the skilled personnel shortages which already exist as a result of losses from the attack. And even if people are willing to accept standard industrial levels of radiation exposures, the extra effort necessary to control this exposure is time consuming and causes productivity losses.

[REDACTED] The extent to which low level residual radiation levels will impact restoration and recovery is difficult to predict. The psychological mood of the public will probably have a significant influence on its impact. However, it will be a factor of the protracted war environment which must be recognized and dealt with.

### 3-4.2.3 [REDACTED] A Case Study in Volcanic Fallout

[REDACTED] An opportunity to better visualize the nature of the fallout problem came with the May 18 eruption of Mount St. Helens. With authorization from the Wing Commander, 92 Bomb Wing and Headquarters SAC, two researchers visited Fairchild AFB on 5 June. Their purpose was to gain a better understanding of the impact of volcanic fallout on operation of a SAC bomber base and to envision if fallout from volcanic ash might have some common characteristics with fallout from surface burst nuclear weapons.

[REDACTED] When it became apparent some 3 hours after the eruption that the ash cloud would pass over the base, a decision was made to hangar all B52, KC135 and all visiting aircraft that elected to remain. This included an SR-71. (An open house including a flying demonstration had been scheduled and some 60,000 visitors were on the base about this time.) Darkness set in by 1430 (the eruption occurred at 0834) and by 1500 it was like "a moonless midnight." The base was unable to obtain information on the nature (chemical, biological and physical) of the fallout. All persons were advised to remain indoors. By 1900 the sky began to lighten somewhat.

[REDACTED] To illustrate the extent of the dust problem, the group was shown a series of slide photographs taken over a period of several days after the ash fall, of the base, the aircraft and especially their critical components. The dust had penetrated the hangars and interior aircraft compartments. Some screwjacks on the planes which had been covered with lubricant were found to be rusting. The ash apparently absorbs lubricants.

[REDACTED] The research group was also briefed on the problem of ash removal from the runways and paved surfaces. Since the physical and chemical composition of volcanic ash and nuclear fallout from surface bursts are probably considerably different, these measures are omitted in this discussion. However, the fineness of the fallout which travels for several hours will likely be similar in effects on visibility and aircraft operations.

[REDACTED]

[REDACTED] In summary, the immediate problem appeared to be the inability to obtain accurate information on the nature of the dust cloud, i.e., its advance rate and direction and the type of material. This was considerably improved by the time of the second eruption a week later through assistance from SAC Weather Central. (Note the comments in section 5-4.2 on loss of Global Weather Information by facility damage.) After arrival of the fallout cloud the quantity of material and its physical and mechanical properties became the problem—vehicle operations were hampered by lack of visibility, air handling units clogged, humans experienced breathing problems, and the material was so fine that it entered even the areas designated as fallout shelters. Finally, removal techniques took some time to develop and long-term control concepts are still being developed.

[REDACTED] It would be incorrect to presume that conditions resulting from nuclear fallout would be the same. Yet it would be similarly incorrect to presume there are no similarities. One can easily visualize how fully immobilized an area could become if, in addition to having to deal with the mechanical and chemical problems of fallout, people also had to protect themselves from radiation penetrating their shelters. It's easy to envision a lengthy period where little, if anything, is accomplished in large areas of each nation while people protect themselves and wait for the radiation intensity to decay. This could be a significant factor in slowing down the pace of the war and prolonging its duration.

### 3-4.3 [REDACTED] Loss of Reconnaissance and C<sup>3</sup>I

[REDACTED] In a central nuclear war prime targets for immediate neutralization will be reconnaissance and Command, Control, Communications and Intelligence (C<sup>3</sup>I) capabilities. Both sides are going to lose a major portion of their C<sup>3</sup> and almost all of their I, [REDACTED]

[REDACTED] Therefore, the ability to protect and reconstitute C<sup>3</sup>I capabilities will play an important role in determining the outcome of a protracted nuclear war.

### 3-4.3.1 U.S. and Soviet Approach to Use of Space

Over the last twenty years both the Soviet Union and the U.S. have become increasingly dependent on space-based C<sup>3</sup>I assets to meet critical time requirements for high quality control of forces, and strategic and tactical warning. Timely, accurate warning is required to assess an attack to a level of detail sufficient to establish its origin, type, and size. To achieve this capability, warning sensors have been put in space, while ground-based warning systems have been relegated to secondary roles because of their limited performance and survivability. Table 3-6 (Space Dependence Summary) illustrates the degree to which the U.S. dependence on space has grown. Only major examples are shown here; there are, of course, additional dependencies. Table 3-7 highlights different ways the U.S. and Soviets approach space and the emphasis that the Soviets have put on the military application of space.

Figures 3-10 through 3-12 show the large disparity in Soviet military launches to U.S. launches. Points of interest drawn from the charts are:

- The Soviets use many more space launch boosters and satellites than the U.S., with higher production rates.
- As a result, the Soviets have an easier supply problem if they decide to put some launchers and satellites aside for emergency or conflict use. Their pipeline is larger.
- The Soviets have maintained a continual high level of experience among their personnel. Thus, their personnel base should be larger and have achieved a high level of proficiency from this experience base.
- In carrying out their space operations, the Soviets rely on many satellites rather than a few.
- In time of crisis, the Soviets put up and recover many satellites. Many of their satellites are recovered after ground landings within the Soviet Union.

Table 3-6. Space dependence summary.

FUNCTION	1960 PRIMARY SOURCE	1980 PRIMARY SOURCE
SURVEILLANCE o Early Warning	DEW Line	[REDACTED]
o Reconnaissance . Photo/IR . Elint	U2, Tactical Aircraft, Elint Aircraft	[REDACTED]
COMMUNICATIONS (C <sup>3</sup> )	Ground Lines, Microwave, Radio Frequency	Defense SATCOM System (DSCS), GAPSAT Lease, USAF SATCOM
NAVIGATION	Stars/Ground Radio	Navstar, Global Positioning System (GPS)
WEATHER	Ground Observers	Defense Meteorological Satellite Program (DMSP)

In contrast, although the United States places heavy reliance on its space assets, it is not postured to rapidly replace or launch and recover satellites in time of crisis. A 1988 excursion scenario was developed to assess Soviet exploitation of vulnerabilities of U.S. space-based warning systems. The excursion scenario blends denial of space-based warning assets (by overt Soviet action during a crisis) with the principle of surprise. In the excursion, the Soviets exploit the U.S.-Soviet disparity in satellite pipelines and launch capability. The excursion scenario follows:

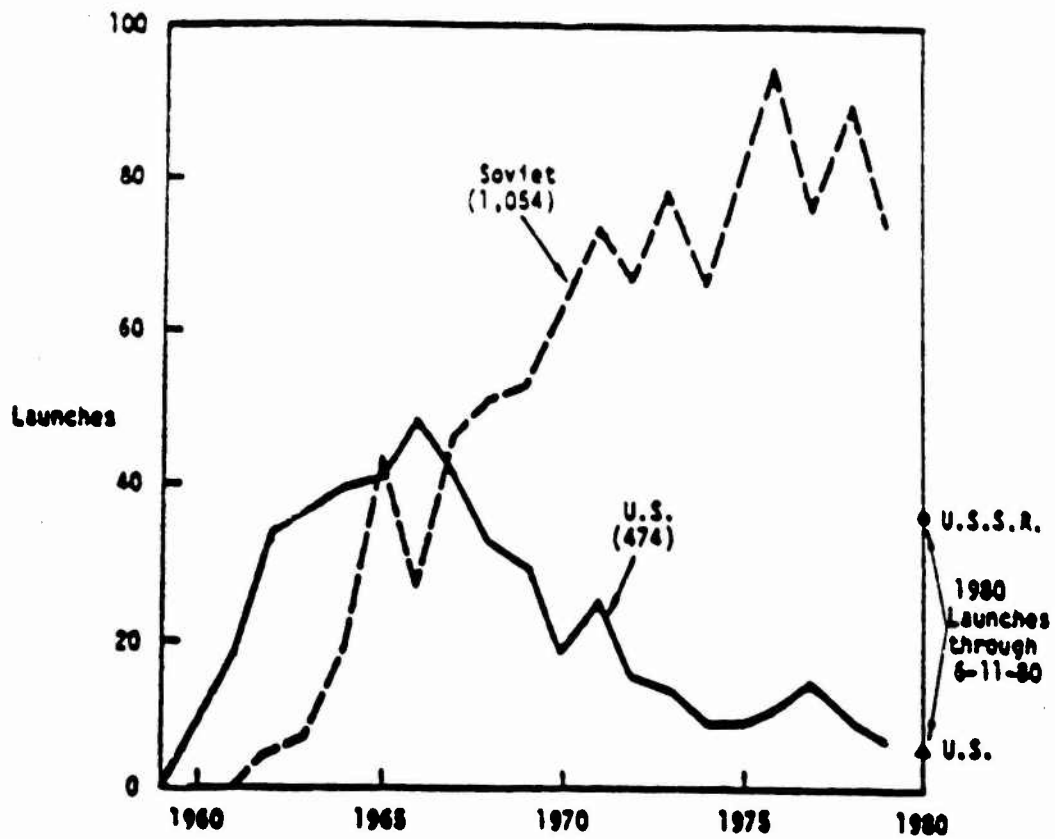


Figure 3-10. Military launch summary.

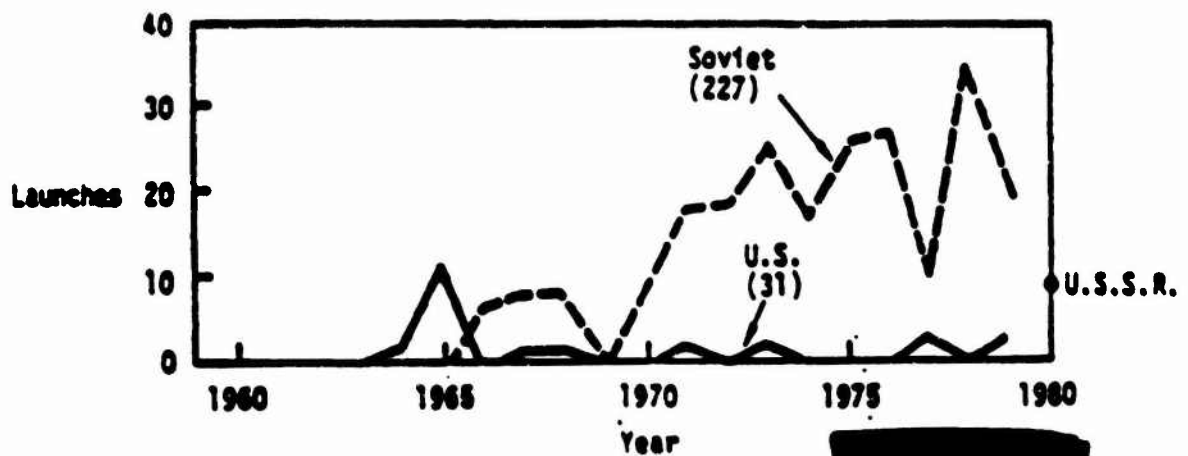


Figure 3-11. Military communication launches.

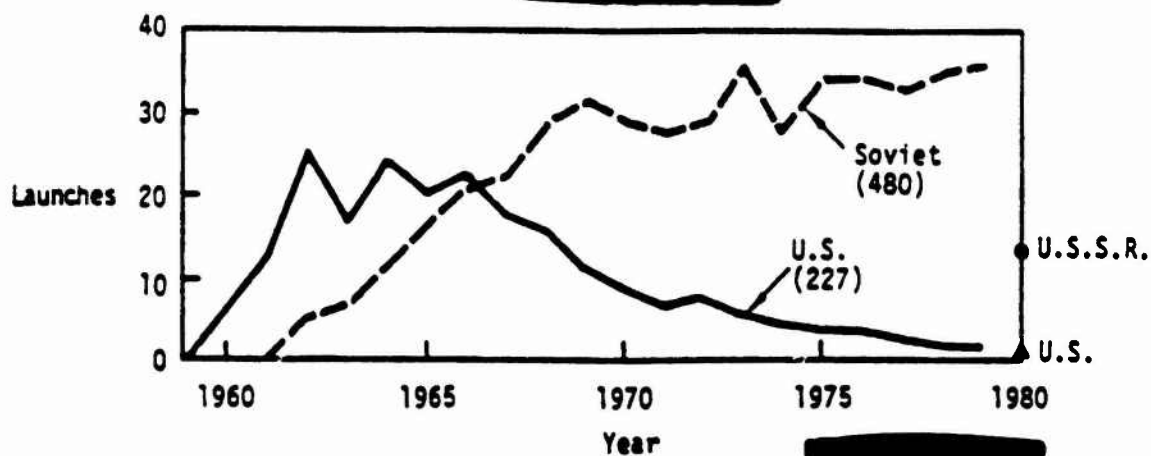


Figure 3-12. Recoverable observation launches.

Table 3-7. U.S.-Soviet summary.

	U.S. SPACE WARFARE	SOVIET SPACE WARFARE
EMPHASIS	<ul style="list-style-type: none"> <li>o Technical Superiority</li> <li>o Small, complicated, and few in number</li> <li>o Sparse pipeline</li> </ul>	<ul style="list-style-type: none"> <li>o Operational Capability</li> <li>o Brute force to numerical superiority</li> <li>o Full pipeline</li> </ul>
PRIMARY USE	<ul style="list-style-type: none"> <li>o Data collections and distribution</li> <li>o Highly dependent for decision making</li> </ul>	<ul style="list-style-type: none"> <li>o Integration into armed forces</li> <li>o Provides military options rather than dependency</li> </ul>
MAJOR ASYMMETRIES		<ul style="list-style-type: none"> <li>o Ocean targeting</li> <li>o Battlefield management</li> <li>o Weapon delivery</li> <li>o Satellite destruction</li> </ul>

The political disintegration of Iran emboldens the Soviet Union to launch a military invasion aimed at capturing the Iranian oil fields.

- Just prior to the invasion, all Soviet military forces are put on conventional and nuclear alert.
- Twenty Soviet Divisions in the Warsaw Pact are placed in a state of highly increased readiness to hold NATO forces in place.
- A partial evacuation of Soviet cities is ordered, estimated at 20 to 60 percent.

The Soviet invasion of Iran results in a confrontation in the Indian Ocean between the U.S. and Soviet fleets. NATO forces are immediately ordered to partial mobilization.

- The U.S. airlifts three Divisions to NATO.
- Tactical Air deploys to NATO/M.E.

The United States issues an ultimatum demanding that Soviet forces be removed from Iran. The Soviets disregard the ultimatum and move to a higher intensity of nuclear force generation.

- Eight Soviet SSBN's begin operations off the U.S. coast.
- LRA aircraft are loaded and dispersed.

The United States initiates a conventional force action in the Middle East with a carrier air strike on Soviet aircraft on Iranian airfields. The Soviets respond by destroying U.S. SOSUS arrays and U.S. satellites— warning, reconnaissance, communications, and navigation. The U.S. responds to the loss of warning satellites by placing SAC bombers on airborne alert. Both sides enter negotiations.

After 15 days, the U.S. gets an early warning satellite back in orbit, but the Soviets promptly destroy it.



- [REDACTED]
- U.S. early warning satellite replacement is given first priority, but U.S. capabilities are extremely limited and no further replacement is possible until the following month.

[REDACTED] The Soviets keep negotiations going for 40 days to stress the SAC bomber force. Then the Soviets back down. The U.S. negotiators are acclaimed for scoring a major diplomatic victory. The Soviets take forces off alert in the Warsaw Pact. Soviet troops leave Iran within two days. The Soviet Fleet in the Indian Ocean disengages from U.S. Naval forces and withdraws. Some Soviet missile submarines (SSBN's) are detected returning to the USSR.

[REDACTED] A U.S. reconnaissance satellite is launched; this one confirms Soviet withdrawal.

- The U.S. early warning satellites have not yet been replaced. Systems relying on warning remain vulnerable.

[REDACTED] Two days after the Soviet retreat, an exultant and greatly relieved U.S. relaxes its SAC airborne alert and assumes a day-to-day strategic nuclear success, the Soviets unexpectedly launch a first strike against U.S. targets. The strike is structured to avoid initial SLBM detection by Pave Paws radars until it is too late for most of the alert B-52s to launch for survival.

[REDACTED] Figure 3-13 illustrates the impact of warning sensor denial in this scenario. The column on the left shows the net advantage in equivalent weapons the Soviets could achieve from a surprise attack with both sides on a normal day-to-day alert rate. The center columns shows the smaller net advantage the Soviets could achieve should they attack after sensor denial while both sides are at maximum readiness. The right hand column shows the increased net advantage the Soviets could achieve in a post-crisis U.S. relaxation period with nonoperating U.S. warning systems.

[REDACTED]

### 3-4.3.2 [REDACTED] Anti-satellite Warfare

[REDACTED] War in space may occur prior to nuclear exchange, especially in the event of escalating hostilities. Possible targets in space for attacks by anti-satellites (ASATS) or other weapons such as lasers include:

- Early warning satellites for detecting missile launch
- Elint satellites
- Reconnaissance satellites (photo)
- Communication satellites

[REDACTED] Targets for war in space may be selected and attacked for the purpose of increasing the effectiveness of a follow-on nuclear attack, and to lessen the amount of damage to the initiator by weakening the opponent's retaliatory strike. Table 3-8 lists some specific Soviet incentives for attacking U.S. space assets prior to a nuclear exchange.

### 3-4.3.3 [REDACTED] Fundamentals of Anti-satellite Operations

[REDACTED] Successful anti-satellite operations are very difficult to achieve. To make an ASAT work, one must:

- Detect and track the target satellite to a very high degree of accuracy.
- Calculate the target satellite's predicted time, path, and position for the time of the intercept. This requires rapid, powerful computing capability.
- Have an ASAT at a base that permits the ASAT to intercept the target.
- Have a rapid and reliable C<sup>3</sup>I net to the ASAT base to get the ASAT readied for the predicted intercept.
- Track the target satellite for updating the data.
- Make a rapid and accurate update on the target satellite's predicted time, location, and path just prior to launch of the ASAT.
- Be able to communicate the updated targeting data and launch execution in a timely manner.

[REDACTED]

As can be seen from the above, a near real time C<sup>3</sup> support system is necessary to establish a workable ASAT system. This near real time C<sup>3</sup> system must integrate data from widely dispersed radar and optical sensors, and process the data for ASAT coordination and control, as well as generate the commands and transmit the commands to the ASAT.

[REDACTED] These are formidable requirements. The system which supports them is massive, complex, and extremely vulnerable. It also requires time to function. Time is needed to detect the target, to track it to sufficient accuracy, and to ready the interceptor. If any portion of the system is destroyed, successful anti-satellite operations would be doubtful or impossible.

[REDACTED] Table 3-8. Incentive for pre-exchange space warfare.

- o ATTACKING U.S. ASSETS PRIOR TO INITIAL NUCLEAR ATTACK MAY CAUSE:
  - o WARNING SYSTEMS:
    - SAC BOMBER FORCE MADE VULNERABLE
    - . ASSESSMENT OF INITIAL ATTACK LOST
  - o RECONNAISSANCE:
    - WAR PLANNING FUNCTIONS GRADUALLY DEGRADED
    - . IMPAIRMENT OF LONG-LEAD WARNING AND INTELLIGENCE FUNCTIONS
    - . COMPREHENSIVE ATTACK ASSESSMENT LOST
  - o C<sup>3</sup> SYSTEMS:
    - RESPONSE TO THREATS DELAYED
    - . ABILITY TO RAPIDLY POSTURE FORCES DEGRADED
  - o NAVIGATION SYSTEMS:
    - ACCURACY DECREASED
    - . DECREASED COORDINATION OF FORCES
    - . INCREASED RISK TO U.S. FORCES
  - o WEATHER SYSTEMS:
    - FORCE EFFECTIVENESS DECREASED
    - . RISK TO FORCES

The following quotes are taken from "Fundamentals of Astrodynamics" by Roger R. Bate, Donald D. Mueller, and Jerry E. White, reference 4. They are pertinent in describing how difficult is the task that must be accomplished in order to establish orbital determination of objects in space.

(Note: The following is directly quoted from an unclassified publication.)

(The Quotes are Unclassified)

#### *Orbit Determination From Optical Sightings*


*The modern orbit determination problem is made much simpler by the availability of radar range and range-rate information. However, the angular pointing accuracy and resolution of radar sensors is far below that of optical sensors such as the Baker-Nunn camera. As a result, some method of orbit determination proceeding from angular data only (e.g., topocentric right ascension and declination) is required.*

*Six independent quantities suffice to completely specify a satellite's orbit. These may be the six classical orbital elements or they may be the six components of the vectors  $r$  and  $v$  at some epoch. In either case, an optical observation yields only two independent quantities such as  $El$  and  $Az$  or right ascension and declination, so a minimum of three observations is required at three different times to determine the orbit.*

#### *Space Surveillance*

*In the preceding sections we have seen how, in theory, we can determine the orbital elements of a satellite from only a few observations. In practice, however, a handful of observations on new orbiting objects can't secure the degree of precision needed for orbital surveillance and prediction. Typical requirements are for 100-200 observations per object per day during the first few days of orbit, 20-50 observations per object per day to update already established orbits, and finally, during orbital decay, 200-300 observations to confirm and locate reentry.*

*In 1975 there were nearly 3,500 detected objects in orbit around the earth. By 1980 this number is expected to grow to about 5,000.*



## **The Spacetrack System**

The task of keeping track of this growing space population belongs to the 14th Aerospace Force of the Aerospace Defense Command. The data needed to identify and catalogue orbiting objects comes from a network of electronic and optical sensors scattered around the world and known as the "496L Spacetrack System." Spacetrack is a synthesis of many systems: it receives inputs from the Ballistic Missile Early Warning System (BMEWS), the Electronic Intelligence System (ELINT), the Navy's Space Surveillance System (SAPSUR), and over-the-horizon radars (OTH). In addition, other sensors are available on an on-call basis: observations are received from the Eastern and Western Test Ranges, the White Sands Missile Range, the Smithsonian Astrophysical Observatory's optical tracking network, and from Air Force Cambridge Research Laboratories' Millstone Hill radar.

In addition to just cataloguing new space objects the mission of Spacetrack has been extended to reconnaissance satellite payload recovery, anti-satellite targeting, manned spacecraft/debris collision avoidance, spacecraft failure diagnosis, and midcourse ICBM interception. At present, the greatest effort is being expanded on just keeping track of the existing space traffic--a job made more difficult by the Soviet's accidental or deliberate explosion in orbit of satellites and boosters, forming "clouds" of space debris.

### **Type and Location of Sensors**

Since space surveillance is an outgrowth of ballistic trajectory monitoring, it is not surprising that all of our radar sensors are located in the Northern Hemisphere. Satellite tracking cameras deployed around the world by the Smithsonian Astrophysical Observatory (SAO) in support of the recent International Geophysical Year (IGY) provide the data from the Southern hemisphere.

## Radar Sensors

Radar sensors can be broadly categorized into two types: detection fans and trackers. The detection fans--most of which are part of the BMEWS system--consist of two horizontal fan-shaped beams, about  $1^{\circ}$  in width and  $3\text{-}1/2^{\circ}$  apart in elevation sent out from football-field-size antennas. The horizontal sweep rate is fast enough that a missile or satellite cannot pass through the fans undetected. These detection radars with a range of 2,500-3,500 miles make about 12,000 observations per day--mostly of already catalogued objects. If an "unknown" ballistic object is detected, the precomputed impact area is determined by a "table look-up" procedure at the site based on where the object crossed the two fans and the elapsed time interval between fan crossings.

At present there are two FPS-17 detection radars at Diyarbakir, Turkey, and three more at Shemya in the Aleutians. Four of the larger FPS-50's are deployed at Thule, Greenland, while three are located in Clear, Alaska. One of the earlier detection radars, the FPS-43, at the Trinidad site of the Eastern Test Range, is now on active Spacecraft alert. The only other detection fan which supplies occasional data to Spacecraft on request is located at Kwajalein Island.

The best orbit determination data on new satellites comes from the tracking radars scattered around the Spacetrack net. There is usually one tracker associated with each detection radar that can quickly acquire a new target from a simple extrapolation of its track through the detection fans. A typical tracker such as the FPS-49 has an 85-foot mechanically-steered dish antenna weighing 106 tons and is capable of scan rates up to  $10^{\circ}$  per second. The prototype is located at Moorestown, New Jersey, and is on active spacetrack alert. One FPS-49 is at Thule and three are at Fylingdales Moor in Yorkshire, United Kingdom. An advanced version of this tracker (the FPS-92) featuring more elaborate receiver circuits and hydrostatic bearings is operating at Clear, Alaska.

In addition, there is an FPS-79 at Diyarbakir and an FPS-80 at Shemya. The one at Diyarbakir has a unique feature which enhances its spacetrack usefulness. A variable-focus feed horn provides a wide beam for detec-

[REDACTED]

tion and a narrow beamwidth for tracking. Pulse compression is used to improve both the gain and resolution of the 35-foot dish antenna.

An interesting new development in tracking is the PPS-85 with a fixed "phased-array" antenna and an electronically-steered beam. The prototype located at Eglin AFB, Florida, gives radar coverage of the Caribbean area. It is capable of tracking several targets simultaneously.

One other radar sensor that contributes to the Spacetrack System is over-the-horizon radar with transmitters located in the Far East and receivers scattered in Western Europe. OTH radar operates on the principle of detecting launches and identifying the signature of a particular booster by the disturbances it causes in the ionosphere.

#### Radio Interferometers

Another class of sensors which provide accurate directional information on a satellite is based on the principle of radio interferometry. The original system using this technique was Minitrack--used to track Vanguard. It was a passive system requiring radio transmitters aboard the satellite. The Navy's SPASUR net is an active system of three transmitters and six receiving antennas stretching across the country along 33°N latitude from California to Georgia. The transmitters send out a continuous carrier wave at 108Mc in a thin vertical fan. When a satellite passes through this "fence," a satellite reflected signal is received at the ground. The zenith angle of arrival of the signal is measured precisely by a pair of antennas spaced along the ground at the receiving site. When two or more receiving sites are used, the position of the satellite passing through the fence is determined by triangulation. To obtain a preliminary orbit from the first pass through the fence, the rate of change of phase between the most widely spaced antenna pairs in the East-West and North-South directions is used to determine the velocity vector. An orbit obtained in this way is used is very crude, but is useful in predicting the next pass through the system. After the second pass, a refinement can be made as the period, and therefore, the semi-major axis, is well established. These observations give information from only one part of the satellite orbit, but after 12 hours the earth

[REDACTED]

rotates the system under the "backside" of the orbit allowing further improvement of the orbital elements. Considering the type of observational data received, SPASUR is best utilized in the role of updating already established orbits by differential correction techniques.

#### Optical Sensors

SAO operates more than a dozen optical tracking stations around the world, each equipped with a Baker-Nunn telescopic camera. In addition to these, two Baker-Nunns are operated by 14th Aerospace Force at Edwards AFB and Sand Island in the Pacific, and the RCAF operates one at Cold Lake, Alberta, Canada. The Baker-Nunn instrument is an F/1 Schmidt camera of 20-inch focal length with a field of view  $5^{\circ}$  by  $30^{\circ}$ . The camera alternatively tracks the satellite and then the star background. A separate optical system superimposes, on the same strip of Cinemascope film, the image of a crystal-controlled clock which is periodically illuminated by strobe lights to establish a time reference. From the photograph the position (topocentric right ascension and declination) of the satellite can be accurately determined by comparison with the well-known positions of the background stars.

Under favorable conditions, the instrument can photograph a 16th magnitude object; it recorded the 6-inch diameter Vanguard I at a distance of 2,400 miles.

Despite the high accuracy and other desirable features, the Baker-Nunn data has certain inherent disadvantages. For a good photograph the weather must be favorable, seeing conditions must be good, and the lighting correct. The latter condition means the site must be in darkness and the satellite target in sunlight. As a result, it is usually impossible to get more than a few observations of the orbit at a desired point for any particular spacecraft. Further, precise data reduction cannot be done in the field and, in any case, takes time.

In any case, the Baker-Nunn cameras provide one of the few sources of data from the Southern Hemisphere and are extensively used for calibration of the radar sensors in the Spacetrack net.



## Typical Sensor Errors

With all the radar trackers located in the Northern Hemisphere, it is not surprising that the predicted position of a new satellite after one revolution can be in error by as much as 100 km. An intrack error of this amount would make the satellite nearly 15 seconds early or late in passing through a detection fan or the SPASUR fence. Several factors combine to make these first-pass residuals large. (A residual is the difference between some orbital coordinate predicted on the basis of the preliminary orbital elements and the measured value of that coordinate.) Sensor errors themselves contribute to the residuals. For detection radars, satellite position uncertainties can be as high as 5,000 meters, while for tracking radars the uncertainty can vary from 100 to 500 meters depending on whether they use pulse compression. Doppler range-rate information on the other hand, is relatively accurate. Radial velocity uncertainties may be as low as 1/6 meter/sec. Most of the Spacetrack radars can achieve pointing accuracies of 36 arc-seconds. Unfortunately, radar sensors need almost constant recalibration to maintain these accuracies.

The radio interferometer technique (Minitrack, SPASUR) yields directional information accurate to 20-40 seconds of arc and time of passage through the radio fence accurate to 2-4 milliseconds.

The most accurate angular fix is obtained from Baker-Nunn camera data. On-site film reduction is accurate to only 30 seconds of arc but films sent to Cambridge, Massachusetts, for laboratory analysis yield satellite positions accurate to 3 arc-seconds.

Another source of sensor inaccuracy is the uncertainty in the geodetic latitude and longitude of the tracking site. These uncertainties contribute 30-300 meters of satellite prediction error.

Even if all sensor errors could be eliminated, persistent residuals of about 5 km in position or 0.7 seconds in time would remain. The persistent residue levels are due to departures from two-body orbital motion caused by the earth's equatorial bulge, nonuniform gravitational fields,

[REDACTED]

*lunar attraction, solar radiation pressure, and atmospheric drag. Although general and special perturbation techniques are used to account for these effects, more accurate models for the earth and its atmosphere are needed to reduce the residuals still further.*

(END OF QUOTE)

[REDACTED] All of this shows how difficult it is to make an ASATS system work, even if everything described above is functioning. None of the near-term improvements in our surveillance capabilities, even GEODSS (Ground-based, Electro-Optical, Deep Space Surveillance System), will significantly remove this vulnerability.

[REDACTED] The development of GEODSS greatly increases the U.S. capability to detect and track objects in space to a degree accurate and timely enough to support anti-satellite operations, but there are only to be five GEODSS sites. All may be easily attacked to negate the system. In addition, the computational and C<sup>3</sup>I demands, including time to execute requirements from last update, of anti-satellite operations make anti-satellite operations extremely vulnerable to nuclear and other attack.

#### 3-4.3.4 [REDACTED] Satellite System Components

[REDACTED] Figure 3-14 shows a typical space system. There are three types of facilities which must interact to make the overall system work. They are launch, surveillance/tracking, and tracking, telemetry & control (TT&C). Note that tracking capability plays a role in both surveillance and TT&C. Users of a satellite system may, in addition, acquire or pass data through a fourth type of separate link. The Effective Radiated Power (ERP) of the satellite's transmitter dictates the size of the user's antenna and aiming requirements. Powerful satellites permit smaller and more mobile receiver antennas. All of these components of the system represent targets that can be attacked.

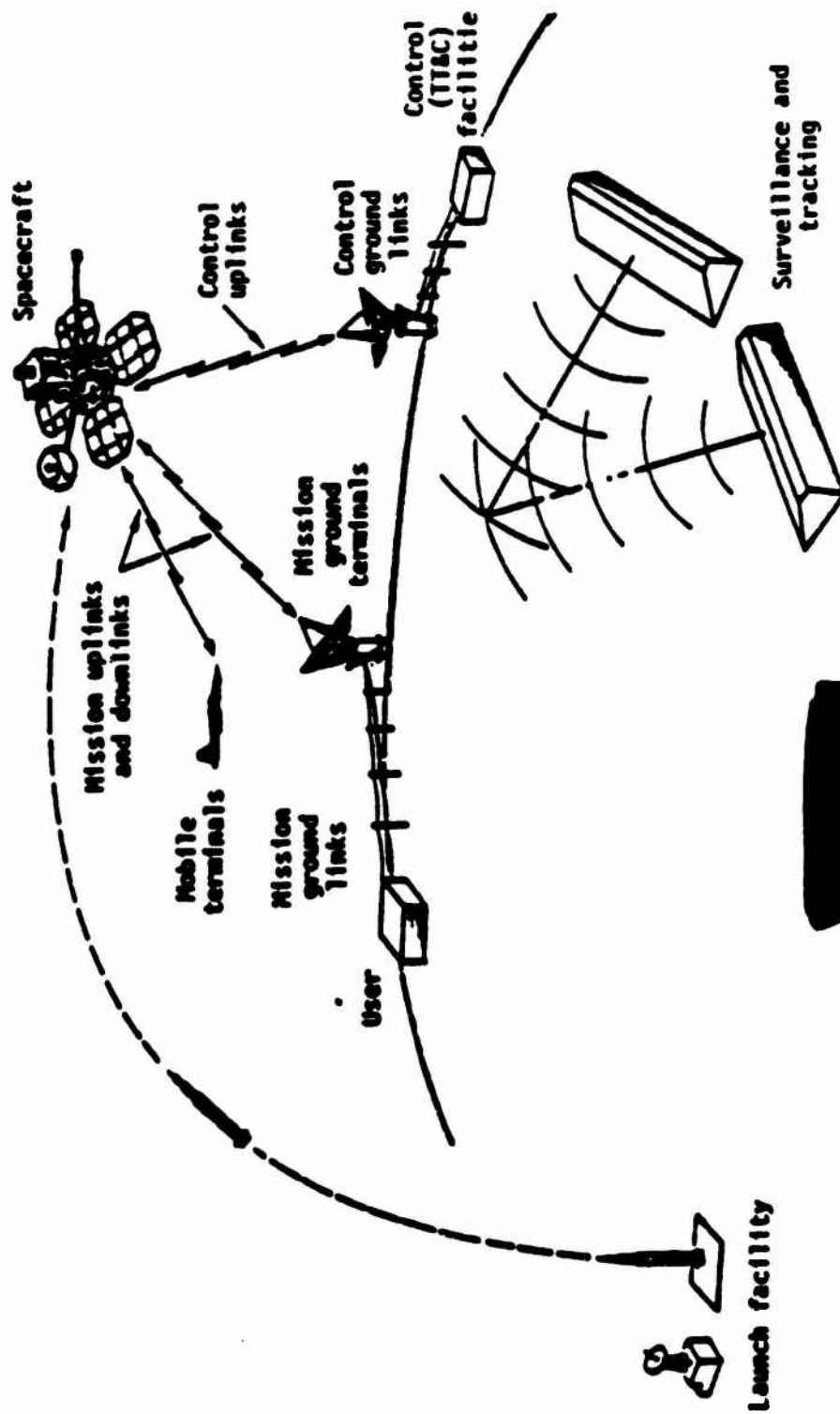


Figure 3-14. Generic space system.

3-4.3.5 Vulnerability of Ground-Based Assets

During a nuclear exchange, targeting emphasis will undoubtedly shift to surface-based space related facilities. The vulnerability of these facilities will mean the termination of the following functions:

- A. Control of satellites - Control of satellites is dependent on our ability to track, interrogate and control them. Therefore, tracking, telemetry & control (TT&C) and user facilities which keep the satellites in the proper orbit/location and perform various operating functions would be destroyed in the attack.
- B. Space surveillance - Radar and electro-optical tracking sites would be destroyed to the extent that satellites may not be detected and tracked, especially to the extent of preventing tracking accuracy sufficient to permit employment of an anti-satellite.
- C. Launch facilities - Which could be used to replenish assets in space.
- D. To accomplish A and B above, against the U.S., the USSR would destroy the following two classes of targets:
  - (1) USAF (TT&C) & User Control - Provides for communication with and control of U.S. satellites. All U.S. space systems are vulnerable to the loss of TT&C. Table 3-9 shows the makeup of the Air Force TT&C system. In the event of damage, the Air Force cannot switch over to the NASA control system for control of Air Force satellites. Air Force TT&C is based on the Satellite-to-Ground Link System (SGLS), which is not compatible with NASA's Space Tracking Data Network (STDN). Improvements are expected to be made to the Air Force system. The upgrade, called Data Systems Modernization (DSM) is expected to include a backup Satellite Operations Center (SOC).

Table 3-9. USAF telemetry, tracking, and control.

0 USAF TT&C consists of -

- o One satellite control facility (AFSCF) in Sunnyvale, CA
- o 10 remote tracking stations at 7 sites

<u>Sites</u>	<u>60 ft</u>	<u>40 ft</u>	<u>14 ft</u>
Guam	X		
Hawaii	X	X	
Indian Ocean	X		
New Hampshire	X	X	
Vandenberg AFB	X	X	
Thule			X
Kodiak*			X

\* Inactive

Additionally, each satellite user group is required to control, process, and/or coordinate its own mission from a few special earth terminals. These stations for DSCS II, DSP, etc. are included in the target list.

- (2) Space Surveillance - Provides assistance in tracking U.S. satellites, and is the primary means of tracking non-U.S. satellites (vital for anti-satellite operations). Table 3-10 lists the components of the U.S. Space Surveillance Network. The radars are needed to help detect items in space and obtain a precise track for orbital calculations. However, radars may not detect small objects at great height, unless the radar is very powerful and very large. Large powerful radars are generally more vulnerable to attack. It is not necessary to destroy all of the optical or radar tracking sites in order to prevent anti-satellite operations. The current U.S. tracking system has incomplete world wide coverage, and it is not considered unusual for the system to "lose" satellites, especially high ones. This includes high satellites that the U.S. has launched which have lost

[REDACTED]

their radar beacons or have had other malfunctions. This has occurred despite employment of all of the operational sites listed in the Tables.

[REDACTED] Table 3-10. U.S. space surveillance and tracking.

0	Radars	
o	Phased Arrays	5
o	BMEWS	3
o	Other tracking sites	11+
o	Sites to fill Western gap	3
0	Optical tracking and identification	
o	Ground-based, electro-optical, deep-space surveillance system (GEODSS)	5
o	Other sites	11+
	Total	<hr/> 38+

[REDACTED]

#### 3-4.3.6 Soviet Space-related Targeting Objectives

In a central nuclear exchange the Soviet Union could easily knock out the ground-based, space-related assets of the U.S. Table 3-11 lists those assets the Soviets would most likely target in the postulated attack on U.S. forces. While this vulnerability represents the "Achilles heel" of the U.S. military space program, the comparable Soviet space-related assets are equally as vulnerable.

Table 3-11. Space related targeting.

USAF TT&C	8
NASA tracking, etc.	2
Space surveillance	38+
Launch facilities	3
	<hr/>
	51+
 User control and consoli- dation facilities	 30+
	<hr/>
Estimated total	<100*
* Not colocated with other high-priority targets	

#### 3-4.3.7 Effect of Attack on U.S. C<sup>3</sup>I Targets

Destruction of these control facilities (coupled with the loss of the surveillance facilities) would cause present U.S. space-related C<sup>3</sup>I capabilities in some cases to be terminated immediately and in other cases to degrade, some rapidly and others more gracefully. These are illustrated in Figure 3-15 and discussed below.

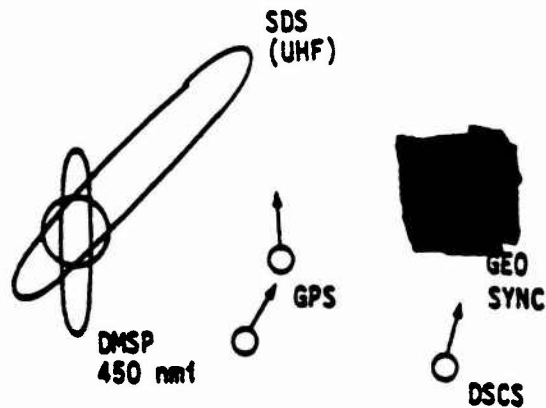
[REDACTED]

All U.S. space systems will degrade without TT&C.

- Sensitivities: data links, orbital control, functional control

Examples

- Immediate loss- [REDACTED]
  - [REDACTED]
- In about 1 week, SDS (uhf communications) lost
  - Orbital positioning
- In about 1 month, DSCS (shf communications) lost
  - GEO positioning
- Indefinite
  - GPS (navigation) clock setting
  - DMSP (weather) two key-down links and sun synchronous



[REDACTED] Figure 3-15. Impact of attack on TT&C and major ground links.



[REDACTED] A. Immediate loss: Early warning and nuclear detonation detection capability presently provided by [REDACTED] [REDACTED] would cease functioning immediately if attacked. This system, which utilizes [REDACTED] large computing facilities, and several data transmission modes, is quite vulnerable. Loss of this system would adversely impact U.S. anti-satellite capability. Other user control facilities have a similar instant impact.

B. Degrade: U.S. space-related systems will degrade in the absence of ground-based TT&C functions. Without satellite control, low orbit vehicles become useless in a few hours while high orbit (out to synchronous) become questionable beyond 15 days. Communications connectivity becomes critical when satellite systems fail to function normally. In all cases present U.S. satellites will not maintain their precise orbital positioning. Geostationary satellites will drift away from their positions. Lower satellites will not maintain precise orbits. Depending on the satellite system and its function, other factors may require regular updating, such as precise timing or clock setting for navigation satellites, in order to meet specified performance parameters. Some satellites must be accurately positioned or tracked in order to maintain communications with them. Others have such low ERP or high anti-jamming requirements that very large dish antenna (which are vulnerable) must be used to receive their transmissions. Some satellites have strong transmitters with relatively broad beams and can be utilized for the transmission of data, etc., by many users even if the satellite wanders a considerable distance from its optimum position or orbit. Some examples listed for illustrative purposes are:

Short Degrade: Systems which may have a shorter period of utility might include the Satellite Data System (SDS) UHF communications satellites.

[REDACTED]

Medium Degradate: The Defense Satellite Communications System satellites (DSCS II & III) are an example of a system that might degrade gracefully if user net control is not disrupted and still provide useful service to many users as long as 30 to 60 days in the absence of TT&C.

Longer Degradate: The present weather satellites represent a longer degrade example. The satellites would probably continue to provide local weather information to many U.S. military users around the globe for periods considerably longer than 60 days. However, the strategic weather services it provides would be immediately lost with the destruction of the two associated ground facilities located at Fairchild AFB and Loring AFB.

#### 3-4.3.8 [REDACTED] Cumulative Effect of the Degradation of Space-Related C<sup>3</sup>I

[REDACTED] The impairment of United States space-related C<sup>3</sup>I during a protracted nuclear war could be devastating. Loss of the warning systems would make the strategic delivery systems more vulnerable, and loss of our initial assessment capability would leave the National Command Authority with a higher degree of doubt concerning the course of the exchange than may be anticipated. The response to threats may become agonizingly slow, and war planning functions deteriorate due to the difficulty of obtaining reliable and timely intelligence. This will be exacerbated by the delays in posturing and executing forces. The lack of warning systems will result in the continuing surprise effect of Ballistic Missile strikes. This effect may be so extreme as to cause a breakdown of morale. The resiliency of the United States may depend, to an inordinate degree upon the faith of the National Command Authority in the ability of individual commands to function without the degree of guidance and control that has characterized U.S. military C<sup>3</sup>I since the advent of space-based communications.

### 3-4.3.9 [REDACTED] Space C<sup>3</sup>I Environment After the Initial Exchange

[REDACTED] Each side would want to replace its space-related C<sup>3</sup>I functions. Conversely, each would want to prevent the other side from doing so. Denial or replacement space-based assets to an enemy may be impossible. The loss of launch detection and azimuth, coupled with the loss of the very large radars used for space surveillance, would negate U.S. anti-satellite capabilities. In effect, the U.S. would not know when an opposing satellite was being launched, would not know that the U.S. was being overflowed, or for how long or when the satellite was returned to Earth. Even if an opposing satellite were detected, it would not be likely that sufficiently accurate tracking data could be obtained to support targeting and launch of an anti-satellite weapon.

[REDACTED] It is assumed, for the purpose of this study, that the U.S. could effectively attack Soviet space-related facilities to the same degree of thoroughness as that of the Soviet attack we have postulated. If such attacks took place, the overall space environment, for the near future, would become relatively benign. Systems in space would be relatively free from attack. In effect, space would become a sanctuary. Satellites which could maintain themselves with essentially no control from ground-based systems could provide continuing service. Similarly, replacement systems, of the same independence, could restore functions lost by less self-sustaining systems which had relied upon vulnerable surface-based facilities.

[REDACTED] The communication switching nodes that connect autovon, audodin, and autosevocom are located in [REDACTED] the largest cities and may not be attacked directly but would be vulnerable to EMP created by large high altitude bursts. The terminals would be blacked out and would seriously limit connectivity. To ensure connectivity with surviving or reconstituted communications satellites, the user sites should be mobile and proliferated.

[REDACTED]

3-4.3.10 [REDACTED] Requirements for Space-Based C<sup>3</sup>I in the Protracted Warfare Environment

[REDACTED] Table 3-12 lists the likely requirements for U.S. space assets in a protracted war. In time of conflict, use of all of the functions provided by C<sup>3</sup>I systems increases dramatically. As a result, there will be intense pressures placed upon those systems at a time when they are either disabled or in the process of degrading because of the effects of the attack.

[REDACTED] Space candidates for reconstitution would include communications satellites for force status, execution, and control; reconnaissance satellites for detecting enemy activities and status; and early warning satellites to warn of enemy missile launch.

[REDACTED] Table 3-12. Essential space assets.

Warning Systems - Essential: Survival of remaining armed forces personnel, must provide warning compatible with extent of reconnaissance denial for force survival.

Reconnaissance Denial - Essential: Long-term survival of remaining forces.

Communications Systems - Expanded: Increased traffic volume and priority, required force coordination and reconstitution, need for back-up systems, and poor response times of other systems.

Reconnaissance - Expanded: Increased demand for intelligence, knowledge of enemy initiatives, targeting and assessment requirements.

Navigation Systems - Expanded: Loss of ground based nav-aids, and required moving target attack capability.

Weather Systems - Expanded: Replace loss of on-site observations.

[REDACTED]

[REDACTED]

[REDACTED] Replacement of space-based assets may not alleviate the problem unless the replacement satellite has either (1) an auto-nav/auto-positioning system, coupled with self-contained control capability and sufficient ERP to permit survivable relatively small ground/air mobile receivers/transmitters (with attendant small antennae) to handle their TT&C, and communication of data or (2) sufficient TT&C capability has survived the nuclear attack or has been reconstituted. At present, no U.S. space-based satellites have the type of capabilities described in (1) above. Nor is the likelihood of TT&C capability survival high at present. Moreover, since the United States does not have a plethora of boosters, satellites, and launch facilities, it is not likely that present systems or hidden, dispersed, or duplicative survivable launch capabilities will survive in the quantities which will be required.

[REDACTED] Provision in the near future for some reconstitution may be possible with nonground dependent, less sophisticated, less capable systems which can provide minimum but vital capabilities, especially in reconnaissance and early warning. In the longer term, U.S. satellites should clearly be made less dependent, or even independent, of vulnerable surface-based control. Survivable, concealed launch facilities, boosters, and satellites should be set aside. In the same vein, a parallel effort should provide for reconstitution of space object tracking sufficient to provide both Early Warning and data for anti-satellite operations.

#### 3-4.3.11 [REDACTED] Soviet Space Capabilities vs. U.S. Space Needs

[REDACTED] The Soviet Union would suffer many similar difficulties with regard to postexchange employment of its space-based assets. The loss of ground-based radars and TT&C would, in most cases, cause the Soviets to lose their ability to control their deployed satellites, resulting in loss and degradation of the satellite functions. They would be concurrently impeded from either replenishing satellites or employing anti-satellite weapons in their normal manner due to loss of launch facilities and tracking capability.

[REDACTED]

[REDACTED] There are, however, significant differences in the way the Soviets have approached space. These differences could make it easier for the Soviets to replenish space assets if they choose to do so. The Soviets have a larger production base of missiles and space boosters from which to set aside concealed reserve satellite boost launchers. They also have traditionally soft landed their photo reconnaissance satellite packages within the Soviet Union. In times of crisis the pattern of Soviet reconnaissance satellite launches has shown a dramatic increase, with the Soviets bringing the satellite down from orbit after relatively short periods. This type of operation requires that large numbers of satellites be readily available in order to respond to crises in a timely manner.

[REDACTED] If some Soviet satellites have been securely stored with, or near, concealed launch boosters, and a disguised hasty-launch facility is available, the Soviets could reestablish reconnaissance or other capability soon after a nuclear exchange. This also implies some capability for auto-navigation, etc., which the Soviets may be able to accomplish, based on their stellar guidance update technology which they have demonstrated on their SLBM's and other missiles.

[REDACTED] Table 3-13 shows the shift in space options as war proceeds from space war before a nuclear exchange, to protracted war after the exchange. Most United States attention has been focused on items on the left side of the chart, i.e., war in space options. The options to defend assets in space are not equally attractive.

[REDACTED] Concealment may be accomplished by putting satellites higher than geosynchronous orbit or by other methods. The drawback is that it is hard to prove invisibility, or reliability of reactivation of silent satellites. There will always be doubt about the effectiveness of the concealment chosen.

[REDACTED] One could choose to proliferate satellites. An example would be to orbit very small autonomous critical function satellites. This is an effective means and is expensive to counter because it would require a large number of anti-satellites to do the job. It is also time consuming to counter. It is also expensive for the proliferator, as well, however.

Table 3-13. Space options.

<u>BEFORE</u>	<u>NUCLEAR EXCHANGE</u>	<u>PROTRACTED WAR</u>
Emphasis on war in space		Emphasis on ground-based assets
0 Attack enemy satellites		0 Attack space-related assets on ground
o Antisatellite weapons		
0. Defend assets in space		0 Defend space functions
o Conceal		o Restore old satellites and functions
o Proliferate		o Space-asset redevelopment
o Responsive counter-measures		o Autonomous satellites
o Rapid redeployment		o Concealed and/or mobile

Responsive countermeasures could be employed to change the satellite velocity, to provide decoys, or to spoof the enemy. This technique requires accurate projections of the future threat in order to work. Also, the track net as planned will not adequately support timely countermeasures to be employed.

Rapid redeployment is an alternative technique which offers positive benefits with relatively few drawbacks. It implies the need for a good pipe-line of launchers and satellites. The Soviets may have such a pipeline now and, therefore be closer to having this capability than the U.S.

Valuable insights are gained when one compares options before nuclear exchange and those following in the protracted warfare period. It rapidly becomes obvious that restoration of old satellites and ground launch functions is unprofitable, because of the ease of attacking the large, vulnerable facilities and radars they require.

[REDACTED]

[REDACTED] Space asset redeployment from concealed and mobile facilities, featuring autonomous satellites would be much more enduring. In addition, this concept dovetails nicely with that of a Rapid Redeployment option in space war before the nuclear exchange (see Table 3-14). Adoption of this technique would give the United States viable, enduring space capabilities across the spectrum of conventional and nuclear war, all at a reasonable cost. It would permit the U.S. to reasonably maintain a war-fighting capability in its space assets even in peacetime, and would ensure the continuation of vital space-related national functions through all phases of conflict.

#### 3-4.3.12 [REDACTED] The Shift of Space War Emphasis

[REDACTED] The analysis of protracted nuclear warfare emphasizes the space warfare dichotomy that exists prior to and after the major nuclear exchange. Prior to the exchange, warfare is more likely to occur in space against space-based assets. During the nuclear exchange, emphasis shifts to attack of surface-based space assets and space itself becomes a relatively benign environment.



Table 3-14. Space options with redeployment.

<u>BEFORE</u>	<u>NUCLEAR EXCHANGE</u>	<u>PROTRACTED WAR</u>
Emphasis on war in space		Emphasis on ground-based assets
o Attack enemy satellites		o Attack space-related assets on ground
. Antisatellite, etc.		
o Defend assets in space		o Defend space functions
. Rapid redeployment		o Space asset redeployment
		o Autonomous satellites
		o Auto-nav and position
		o Housekeeping
		o Onboard computing
		o High-power transmitters
		o Concealed/mobile
		o Launch and TT&C

The nation with the capability to replace satellites and TT&C functions will be best able to reconstitute essential C<sup>3</sup>I functions. The need to deny enemy reconnaissance will be extreme, because of the adverse impact reconnaissance has on continued survivability of forces. Aircraft reconnaissance may provide a poor and very limited substitute. Also high on the priority list will be replacement of an enduring warning system.

#### 3-4.4 Needs, Perceived and Real, to Conserve Strategic Weapons Expenditures

If the nature of protracted war is correctly described here, then each side will wish to avoid escalation to large-scale city attacks for reasons of self-interest. At the same time, each opponent believes that he can either improve his post-war position or emerge victorious by continuing

[REDACTED]

attacks on his opponents military forces. These concepts are not contradictory and have a parallel (albeit on a much reduced scale of risk) in the WWII avoidance of use (widescale) of poison gasses. (As a matter of historical record, each side perceived the other to have a superior capability.)

[REDACTED] Thus, both actual requirements for city attack deterrence, as well as perceptions (or misperceptions) of the opponent's strength will influence the quantity and rate of continuing strategic nuclear weapon expenditure.

#### 3-4.4.1 [REDACTED] Need for a Deterrent Force

[REDACTED] If, after a massive exchange as described, each side's residual capability to inflict massive damage on its opponent's industries and population is to function as a deterrent, then that capability must be real. Each opponent will now have real data points from which to assess such weapon use. Each will undoubtedly perceive the need to either retain or regain the upper hand in the continuing struggle for strategic superiority. These needs will undoubtedly act to slow down continuing weapons expenditure.

[REDACTED] A national leader, faced with such a threat, is going to be reluctant to dribble away a significant portion of his remaining deterrent force in attacks on his opponent's strategic reserves which do not result in substantial attrition of these forces. This will be especially true if his nuclear weapons storage and manufacturing sites have been destroyed or damaged in the initial exchanges.

[REDACTED] On the other hand, should the NCA learn of opportunities to gain a significant advantage in residual deterrent force strength through high-payoff strikes on his opponent's reserves, he will undoubtedly execute such strikes. Hence, reserve weapon vulnerability or exploitability carries a very severe penalty in protracted warfare.

### 3-4.4.2 [REDACTED] Tendency to Hoard Weapons

[REDACTED] In addition to the need for a surviving and enduring deterrent force, there will probably be a tendency for each side to perceive the need to hoard most of its remaining weapons for fear of a sudden and catastrophic loss of the war. The perceived situation may have some historical parallel in WWI. While naval experts may argue on the degree of superiority achieved in the battle of Jutland, the battle was not decisive. Afterwards, there was a distinct reluctance by both opponents to commit their battle fleets to another major engagement. The words of Admiral Jellicoe that he "could have lost the war in an afternoon" emphasize this concern.

[REDACTED] Consider now the dilemma faced by a national leader after a major military nuclear exchange. Not only will his military forces have suffered devastating damage worldwide, but he will also have lost almost all (if not all) of his intelligence-gathering capability. It will be difficult—almost impossible—for him to assess the effectiveness of his strike. Even if he emerged with a vastly improved ratio of superiority, he probably won't know it. Hence, one can visualize his reluctance to undertake a second major exchange with large numbers of weapons.

[REDACTED] This reluctance to use these scarce assets coupled with the fear (real or perceived) that such use could lead to a catastrophic and sudden loss of the war is another reason the war may tend to become protracted—one characterized by the continuing attrition of the opponent's military forces.

### 3-4.5 [REDACTED] Societal Considerations

[REDACTED] There are a multitude of societal considerations which will impact the environment for protracted war which will exist in the aftermath of the nuclear exchange described. Inasmuch as our efforts have focused on improvements which could be made to our military systems and their associated command and control to cope with this environment, we have not studied societal impacts. Further, the staff conducting this effort is not qualified to conduct sociological studies. At the same time it is recognized that societal considerations will make a significant, perhaps even dominant, impact on the environment for protracted war. They are mentioned here to acknowledge that such considerations, while not addressed in this study, must not be ignored.

This chapter has sought to provide insights into the question of what the protracted war environment would be like after a major nuclear exchange. In seeking these insights, we have looked at reasonable Soviet objectives and the structure of a Soviet attack to accomplish these objectives.

The environment has then been characterized in terms of: (1) the attack effectiveness as measured by damage and fatalities, (2) the fallout environment created by this attack, (3) the loss of Command, Control, Communications and Intelligence information which both sides will suffer, (4) the perceived needs and reasons why national leaders will choose to reduce the rate of nuclear weapons expenditures, and (5) an acknowledgement that societal considerations (while not studied here) are of importance.

Rather than postulating a geopolitical scenario for war initiation, we have considered two general cases; the first in which a central nuclear exchange grows out of a theater conflict, and the second in which war is initiated worldwide simultaneously by a Soviet first strike against U.S. military capabilities. To the extent possible, the Soviets are assumed to use surprise or deception to maximize the effect of these strikes.

The two prime Soviet objectives are postulated to be destruction of U.S. military capability and limitation of damage to the Soviet Union. Since destruction of all U.S. weapons is unfeasible, this latter objective is enhanced by holding most of the American population hostage to deter the U.S. from a retaliatory strike on Soviet cities. In such a war where, for reasons of great national self-interest, each side limits its strikes to military targets, the retention of a large and enduring strategic weapons reserve force is of overriding concern. We structured a Soviet attack compatible with these objectives which left the Soviets with a large reserve for escalation dominance.

[REDACTED]

[REDACTED] Damage to U.S. forces and facilities from such an attack is extreme, with 1.2 million fatalities among active duty military personnel and damage to military installations ranging from 66 to 80% of these facilities. Of particular concern is the vulnerability of the military logistics infrastructure which has resulted from high concentration of functions and supplies at relatively few locations.

[REDACTED] Radioactive fallout, resulting primarily from surface burst weapons used in attacks on hard targets, is a significant factor in the conduct of a protracted war, particularly in the first two weeks. A high percentage of the U.S. population, in order to survive or avoid serious illness, will have to remain sheltered for one to two weeks. Measures to protect against fallout are fairly easy to implement but are not generally known. The extent to which such measures will immobilize large areas of both nations is a significant factor of the protracted war environment.

[REDACTED] Both the United States and the Soviet Union have moved to a position of very heavy dependence on space for C<sup>3</sup>I functions. Operation of the space systems of both sides is dependent on continuing inputs from a few very vulnerable ground-based facilities. These facilities are also essential to the employment of anti-satellite weapons (ASATs). Destruction of both sides' ground-based space facilities will undoubtedly occur in the initial phases of any nuclear exchange. This will result in rapid (in many cases immediate) degradation of all satellites with the attendant degradation of both sides' C<sup>3</sup>I. Thus, not only will each side lose its near-term ability to assess the effectiveness of the exchange, they will also lose their ability to effectively use ASATs to deny the use of space by reconstituted satellites. Hence, a significant advantage will accrue to the side that first reconstitutes its space assets—an advantage which, based on the present asymmetry in numbers of space launches and in-country recoveries, favors the Soviets. To function in a protracted war environment, the requirements and characteristics of reconstituted satellites will differ considerably and must be much more autonomous than those now used.

[REDACTED]

[REDACTED] National leaders' perceptions (or misperceptions) of enemy strength, coupled with fear of overcommitting scarce and possibly irreplaceable nuclear weapons assets will tend to greatly reduce the rate of nuclear weapon expenditure. These perceptions, coupled with the overriding need for reasons of national self-interest to maintain deterrent against escalation to urban-industrial attacks, will inhibit weapon expenditure. Only when an opponent sees an opportunity for a favorable exchange rate against his opponent's reserve nuclear forces are large salvo-style attacks likely to occur. Instead, the war will become one of continuing attrition against the opponent's military forces.

[REDACTED]

## SECTION 4

[REDACTED]

### MILITARY MISSIONS FOR PROTRACTED WAR

#### 4-1 SCOPE

The postulated initiation of a protracted war considered for this investigation is a central counterforce nuclear exchange attacking nuclear and conventional military bases and C<sup>3</sup>I installations including space-based assets. The purpose of the attack was to excise the United States' capability to project military force while holding U.S. cities and industry hostage in an effort to confine U.S. response by any surviving nuclear forces to military targets. From the postulated attack, initial conditions expected to prevail at the outset of central nuclear war were derived. It is assumed that the results of the initial exchange do not cause a political settlement between the adversaries and the conflict continues. In that continuation, the U.S. national goal is to survive the conflict as a viable political, economic and military entity.

In this chapter U.S. military missions and functions necessary for national survival are identified and described. Additional essential missions for which the U.S. may not have execution capability are also identified. U.S. military missions and functions are discussed essentially in the order of achievability. The highest level represents those contributing to a national goal of resolving the conflict in favor of the U.S. The maintenance of forces for strategic strike capability and protection of the homeland are the two basic military missions essential to national survival. Underlying those missions are the restoration and operation of C<sup>3</sup>I and force logistics functions. At the next level are the protection of allies and assumption of control over critical resource regions.

#### 4-2 MAINTAIN STRATEGIC FORCES AND DEFEND U.S. HOMELAND

It is not the purpose of this study to postulate circumstances and procedures for conflict termination. However, it is sufficient to assume that one adversary or the other may stop fighting when that adversary perceives

[REDACTED]

continuation of the conflict will be at a military/economic/population cost greater than that he is able and willing to accept or bear. It is our purpose to discuss means by which the United States can be in a position to make those choices freely rather than by default, external coercion, or defeat.

It is readily apparent that post-exchange maintenance of a viable, enduring strategic nuclear force is a first-priority necessity. The strategic forces must have survival and endurance in sufficient numbers to provide the ability to display power in a militarily effective manner, to achieve political coercion (or to counteract coercion by others), and to conduct strategic nuclear strikes.

Defense of the U.S. homeland assumes equal priority with the above strategic nuclear mission. The defense of the U.S. homeland involves (1) air space defense, (2) control of contiguous waters and sea lanes, (3) prevention of invasion, (4) neutralization of enemy North and Central American bases of operation, (5) ABM and space defense, and (6) providing C<sup>3</sup>I and logistics to support the mission elements.

#### 4-2.1 Maintain and Use Strategic Forces

In the 1950s the U.S. adopted a triad of strategic attack capabilities: manned penetrating bombers, fixed-site ICBMs, and submarine launched ballistic missiles (SLBMs). (Designated tactical aircraft reinforce as required.) The triad mix of the 1980s and 1990s is emerging as bomber (old or new) with air-launched cruise missiles, mobile ICBMs (as well as fixed ICBMs) and SLBMs. Each component is significantly different in terms of pre- and post-launch survivability, C<sup>3</sup>I, range, reliability, responsiveness, and adaptability, (as well as cost and accuracy). Each of these characteristics impacts on system needs to function in a protracted war scenario.

The concepts for the conduct of protracted war include the use of strategic forces for two major purposes: intermittent strategic weapon strikes against the Soviet Union, or other enemies that arise, and a display of power as required to coerce or to resist coercion to capitulate. Thus it is essential:



[REDACTED]

(1) that sizeable strategic forces survive the nuclear attack on U.S. military bases; (2) that, having survived, they have the endurance, in all their characteristics, to play their role throughout and after the protracted conflict.

#### 4-2.1.1 Provide Enduring Strategic Weapon Systems

Those strategic weapons not used during the initial exchange must be able to survive that attack and retain their military utility. To assure durability and utility, each weapon system has essential requirements imposed upon it. These requirements are listed in Table 4-1.

Table 4-1. Enduring weapon system requirements.

SYSTEM	ESSENTIAL REQUIREMENTS
Bomber (Penetration or Standoff)	Air Bases (prelaunch, dispersal, and recovery) Runways Maintenance Facilities Spare parts Weapon reloads (storage) POL (Petroleum, Oil and Lubricants) C <sup>3</sup> I Dispersal Deception Personnel
ICBMs (Fixed and Mobile)	Hardness Dispersal Deception C <sup>3</sup> I Autonomy Supply and Maintenance Personnel
SLBMs	Detection Avoidance C <sup>3</sup> I Resupply and Services Personnel

In addition to providing surviving and enduring strategic weapon systems, it is necessary to have consumable supplies and trained personnel

[REDACTED]

available. Dispersed shelters probably will provide the most effective protection for essential personnel ranging from mission operations to maintenance and repair, as well as for the consumables associated with the system. Consumables include additional nuclear weapons, equipment spares, POL and human services. These issues are addressed in more detail in Section 4-3 under the heading of C<sup>3</sup>I and Logistics.

#### 4-2.1.2 Conduct Strategic Strikes


Protracted war concepts see two phases of strategic weapon application: initial counterforce central nuclear war and, conflict resolution not being achieved, prolonged countermilitary nuclear war. The specific target definitions become blurred in the second phase. However, Table 4-2 categorizes the type targets emphasized in the protracted phase of the conflict.

Table 4-2. Protracted phase target category.

FORCE ORIENTATION	STRATEGIC NUCLEAR ORIENTATION
Projection-Force Concentrations Transportation and Facilities Concentrations of Sea Power	Command, Communications & Control Surveillance Systems Remaining Strategic Weapons
Sources and Flow of Resources	

Destruction of force-oriented targets contributes to conflict resolution through extrication of offensive combat power. Attack of these targets is suitable to either land, sea or airborne strategic weapons. They may be fleeting targets. Timeliness of attack is dependent on reconnaissance and surveillance.

Nuclear force targets, when acquired, will assume high priority for strike. The relative difficulty of producing new nuclear weapons will increase the value of those remaining; every effort will be made to detect and destroy enemy nuclear weapons and delivery systems.



#### 4-2.1.3 Display of Strategic Power

The resolution of a conflict involving nuclear attacks on U.S. and Soviet military targets will, to considerable extent, depend upon the perception by our opponents, allies, and uncommitted nations. To demonstrate that both capability and resolve exist in the U.S. to resist coercion, and even to coerce other nations support, demonstrative displays of power may be required. Enduring strategic nuclear systems responsive to the national command authority are needed to ensure a strategic strike capability will exist throughout the protracted warfare period.

#### 4-2.2 Defense of U.S. Homeland

The most sacrosanct national interests are survival and physical security. Defense of the homeland is necessary if the United States hopes to preserve its people and economic/industrial base with territorial integrity, national institutions, and human values intact. The necessary adjunct is the national will to survive.

It is not the purpose of this section to postulate or synthesize Soviet strategy and tactics for continued attack of the United States. It is possible, however, to note basic Soviet military capabilities to do so. After the nuclear exchange, the changed relationships of military strength between the nations may alter the kind and degree of threats to the territorial integrity of the United States. The U.S. will need to be able to defend itself against a spectrum of possible threats to U.S. territory, ranging from raids or invasion to aircraft or missile attacks.

Following the initial nuclear exchange, the continental United States may find itself relatively defenseless in conventional capability. Depending on the success of the U.S. retaliation, the same may be true of the U.S.S.R. The balance of conventional capability vis-a-vis other nations may be radically altered.

Nations which have been relatively unaffected by the exchange may feel that they possess sufficient force to get away with aggressive acts which

[REDACTED]

might otherwise be unthinkable. The world's policemen would be non-existent. Such nations may consider that there will never be a more opportune time to strike and redress old grievances or achieve long wished for aspirations. Mexico could decide to retake Texas, New Mexico, Arizona and California. Cuba might seize, or raid, southern Florida. If not struck in the exchange, Cuba might be militarily the most powerful nation in the Central and Northern American Hemisphere. The PRC might act to retrieve the lost Chinese North-eastern Pacific provinces from the Soviet Union.

#### 4-2.2.1 Defend U.S. Airspace

In the development of protracted war concepts it was assumed that both sides retain the capability to continue strategic attacks. The data in Table 3-1 confirms that assumption, as both sides retain at least 1000 weapons. It appears likely that the Soviet Union will preserve a significant portion of its long range aircraft fleet. Continued production of the supersonic BACKFIRE steadily increases the Soviet inventory of heavy bombers. In 1980 that total force consists of some 140 BEARS and BIONS served by some 50 tankers. Some 60 BACKFIRES have been built. The strategic value of that aircraft against the U.S. homeland and contiguous waters is significant. Despite the number of Air National Guard interceptor units surviving at local airports which were not struck in the attack, there will be numerous gaps in defenses through which manned bombers and reconnaissance aircraft could penetrate with ease. The U.S. does not have a realistic SAM & AAA defense system. The United States would be even more exposed if some socialist state in the Caribbean or Central America permitted Soviet aircraft landings and turn-around.

The U.S. must retain or re-establish the capability to defend the homeland against intruding aircraft. Two levels of air defense may be considered. One would be to prevent flight of unfriendly aircraft over U.S. territory, while the other would concentrate on the defense of critical portions of the U.S. airspace. In either case, a combination of fighter-

[REDACTED]

interceptors and surface-to-air missiles, AAA, plus warning, tracking and control systems is required.

The systems for warning and tracking of air space intrusions are part of the overall U.S. C<sup>3</sup>I system and the control of air defense weapons specifically designed for that purpose is a subset of national command and control (discussed below). Surveillance of approaches to U.S. airspace will need to be a continuous function. The capability to monitor Soviet aircraft operations from their bases, which in effect would provide early warning, would be most valuable.

#### 4-2.2.2 Sea Control of Contiguous Waters

Contemporary U.S. strategy dictates that oceans act as barriers for defense of the Continental United States, as avenues for extension of military and political influence abroad, and for international commerce. In protracted war, maintaining the ocean barrier against invasion will be a primary mission. Sea control of contiguous waters is vital. The U.S. must deter or defeat enemy aircraft, submarines (including ballistic missile launchers) and surface combatants that threaten U.S. lines of communication along the coasts or the adjacent land areas. The task will be made more difficult because an early casualty to the initial attack probably will be the anti-submarine Sound Surveillance System.

This mission, like air defense, requires surveillance to detect intruders and the capability to track and intercept as required. Of particular importance, in addition to regular coastal patrol, is the coastal portion of sea lane protection in support of other missions such as the eventual reinforcement of allies.

#### 4-2.2.3 Prevent Invasion

Soviet capabilities to project land power over long distances are not now formidable. However, their capabilities are evolving. In protracted war, the Soviets could gain strategic advantage over the U.S. by employment of

[REDACTED]

airborne assaults on key locations in Alaska or by the employment of ground forces - naval borne - on locations of importance to allies. Examples of the latter are choke points centering on Iceland, the Skagerrak, guarding the Baltic Sea, or the Dardanelles. Of perhaps greater significance during protracted war is the lower level insertion of small, specialized, mission-oriented forces.

Smaller invasions may occur by infiltration of military or para-military forces capable of large scale sabotage. In concert with air and coastal defense the specific task of preventing raids must be assigned. A basic function must be to gather intelligence on potential threats and conduct surveillance of threatening activities.

The response, beyond intelligence gathering and surveillance, must be the existence of rapidly deployable ground, air and sea forces to counter-act such threats. This force must be in addition to that needed to conduct the theater war.

#### 4-2.2.4 Neutralize Cuba and Other Countries as Necessary

Cuba provides an advantage to the Soviets both in the initial nuclear exchange and during the protracted war. The development of the Soviet naval base at Cienfuegos, the use of Cuban airfields as bases for long range reconnaissance aircraft, the existence of Soviet troops in Cuba and the capabilities of Cuban forces have all been documented in detail. Elimination of Cuba as a base for the Soviets by neutralization, destruction, or occupation of the territory will become a primary protracted war mission. In the latter case the existing facilities could be made useful to U.S. purposes.

The proximity of Cuba to the U.S. offers a number of opportunities for attack. Initially, the destruction of air and naval bases offers the most immediate payoff since they form the basis for offensive action against the United States. Elimination of all BACKFIRE landing areas would restrict Cuba's employment in a one-way mission profile. The island is subject to neutralization through mining or, more force intensive, blockading. Finally,

[REDACTED]

occupation and control appears strategically feasible through the U.S. foothold at Guantamano.

#### 4-2.2.5 Provide ABM and Space Defense

Ballistic missiles on both the Soviet and the U.S. side are as yet essentially unopposed because neither country has ever erected an effective ABM shield. Scientists on both sides still pursue credible ABM capabilities within confines imposed by the SALT I Treaty and subsequent protocol. Those documents restrict development and deployment, but not basic research. The stakes are high in achieving success. A breakthrough by either side could shift the strategic balance - for a significant time.

The function of space defense during the period following nuclear attacks on military targets is less clear at this point. It appears that both space and ground based components of space defense systems could easily be destroyed just prior to or during strategic attack. Autonomous space systems launched by either side after the destruction of tracking capability could not be located or attacked. However, the requirement to prevent enemy reconnaissance will be strong during the protracted war. It is reasonable to expect both the U.S. and the U.S.S.R. will attempt to regain a space defense capability as soon as possible after the initial exchange.

#### 4-2.2.6 Provide Required C<sup>3</sup>I and Logistics

The missions addressed above require that a supporting C<sup>3</sup>I infrastructure be in place to assess the need for specific military actions, evaluate the ability to conduct each of those actions, and command their execution. It becomes predominantly clear that the U.S. will be able to conduct a protracted war only with those essential systems in being at the outset or for which restoration/replacement measures have been taken beforehand. The specifics of C<sup>3</sup>I and logistics needs are discussed next.

The conduct of modern military operations is dependent on effective C<sup>3</sup>I capability and at least the end-game portion of the logistics systems. The ability to gather information about the enemy's situation and apparent intent, as well as the status of friendly forces, together with the ability to interpret that information, will remain essential to decision making. A communication network is needed for transmission of information and commands. The logistics system supports military functions with consumables, spare parts and transport. The current assessment, as shown in the previous chapter, is that both of these functions are very vulnerable and special measures are needed to enhance survival and the ability to restore lost capabilities.

#### 4-3.1 Retain/Restore Global and Subordinate C<sup>3</sup>I

The nuclear exchange portion of the protracted war is expected to destroy major command centers and virtually all important military communication system nodes. Enemy actions are expected to destroy or damage space-based surveillance and intelligence gathering systems either by attacks on the space-based assets or on ground stations. It is probable that assessments of our attack results cannot be completed and subsequent enemy actions cannot be observed unless some surveillance capability survives or is restored. Similar conditions apply to global communication relays.

Several essential functions must either survive or be restored to meet the requirements of conducting a protracted war effectively. These include: (1) information gathering, e.g. attack and damage assessment and intelligence gathering, (2) data evaluation and interpretation, and (3) issuing commands. These functions are discussed here on the global, homeland and theater levels.

##### 4-3.1.1 Global Level C<sup>3</sup>I

During protracted war it is essential that the National Command Authorities (NCA) (the President and the Secretary of Defense, together with



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designated alternates and successors) be able to transmit their mandates to unified and specified commanders. Their mandates are transmitted over the world-wide Military Command and Control System (WWMCCS). Communications channels for execution of the Single Integrated Operational Plan (SIOP) and other time sensitive operations are transmitted directly to the executing commanders at appropriate levels. (In an emergency, contact could be directly to ICBM launch control sites or ballistic missile submarines.) Hence, the conduct of military missions must be in response to a continuing national command authority in the U.S. and counterparts in allied regions.

The NCA people require the means to assess the attack effectiveness achieved by U.S. forces and the damage the forces sustained. Next they need to be able to communicate with each other, and to be able to monitor enemy activities. The latter includes the original attacker(s) and any subsequent attackers, e.g. N<sup>th</sup> nations. The remaining tasks are to issue commands to major forces and be prepared to negotiate the conclusion of hostilities.

Most of the capability described above exists now but will be destroyed or severely damaged during the initial attack. It will be necessary to prepare the means and plans for the survival or restoration of the minimum essential WWMCCS capabilities. The SLBM force will retain the greatest continuous strategic strike capability following the initial exchange. Therefore, it is essential that communication be maintained continuously and responsively. Communication with SLBMs is one of our most difficult problems today. It should be our highest post-strike priority for the strategic force. Next will be the surviving bomber force and utilization of surviving and remaining ICBMs. As the U.S. acquires strategic nuclear forces designed and postured for enduring survivability in protracted war, this order may change.

Concurrently, the requirement exists to negate the ability of the Soviet Union to gain intelligence and assess damage of the initial and follow-on strikes. Active and passive measures against space-based and other surveillance will include anti-satellite attack/negation and secure communications. Our ability to conduct anti-satellite operations may be precluded by the initial Soviet attack unless measures have been taken to ensure the

[REDACTED]

survivability and endurance of our critical detection, tracking and computing functions.

The need for interaction between the NCA and the population is recognized but not included in this investigation.

#### 4-3.1.2 U.S. Homeland C<sup>3</sup>I

The first strike damage to military installations and collateral damage to surrounding areas estimated in Section 3 is a formidable state of devastation. The level of devastation will be felt most keenly in the exercise of C<sup>3</sup>I functions pertaining to homeland defenses. While it is an accepted fact that Civil Defense (CD) in the U.S. is designed in the main to mitigate natural disasters, one element of the CD functions appears peculiarly survivable as an institution. That is communications. Americans must communicate. Under the auspices of the Federal Emergency Management Agency and the Federal Broadcasting Information System, Americans have habitually - and effectively - restored communications as a top priority in local and regional survival situations. Although the post attack capability of the population is assessed as being of little help in redressing the immediate military status, the resiliency of the nationwide civil communications network probably will be quite high and of exceptional military benefit.

The primary C<sup>3</sup>I missions will include the restoration of the basic capability to gather information, process it and act upon it. The C<sup>3</sup>I functions applying to military missions have two major aspects. They must be able to effect the defense of the homeland and they must facilitate power projection and allied support activities. The focus of information needs will change during the progress of the protracted war. Initially the emphasis will be on force status. If sufficient military capability remains for continuation of the war, the gathering of information changes in emphasis toward reconnaissance, surveillance, and early warning of threats to the homeland. The C<sup>3</sup> missions must support the interpretation of data on force status and threats, as well as leadership objectives, and to communicate decisions to the forces.

[REDACTED]

Much of the existing C<sup>3</sup>I capability is expected to be destroyed or severely damaged, particularly major command centers. However, in an attack on U.S. military it is probable that a significant number of the U.S. communication system links will survive and remain operable. Rapid restoration of Command centers and warning system sensors will be possible provided advanced planning has been complete. Some concepts are discussed in Chapter 5.

#### 4-3.1.3 Theater C<sup>3</sup>I

The theater C<sup>3</sup>I mission presents complex requirements that differ from those of the homeland C<sup>3</sup>I system. The characteristics of a theater system must permit it to function efficiently in the U.S. system— theater, strategic, and world-wide system (WWMCCS). In addition, it must function well within the systems of our alliances. Two potential theaters are in being; NATO Europe and Korea/Japan. NATO Europe presents the most critical problem as well as the most complex one. A theater C<sup>3</sup>I system must be sufficiently sophisticated to absorb, make use of, and meet the requirements of multinational needs and inputs. The problem is further complicated in that the C<sup>3</sup>I concept is still in its infancy in most Western nations, notwithstanding that some very advanced systems have been developed for specific applications.

Theater C<sup>3</sup>I missions and functions must be responsive to needs, requirements and limitations as discussed below.

Surveillance and Warning. Worldwide strategic surveillance and warning capabilities in the free world lie almost entirely in the assets of the U.S. To be of utility, this information must be processed through the WWMCCS and approved by the NCA for transmission to Theater C<sup>3</sup>I authorities. Security and survivability of this function will remain a hallmark challenge.

Situation Surveillance. The most centralized command and control requirement is found in pre-conflict crisis management when Heads of Government become directly involved in incidents at distant flash points while attempting to contain the situation. Situation awareness so that

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leaders and commanders can determine and execute appropriate actions dictates a powerful C<sup>3</sup>I infrastructure.

Communications With Forces. Modern military operations require control systems for five major functional areas—fire support, air defense, operations control, intelligence, and combat service support (logistics). At theater level, this requires not only combining Service roles and missions functions into a viable C<sup>3</sup>I system, but incorporating that of allies having varying degrees of capability.

Status Monitoring. Force status is an omnipresent requirement at theater level. In addition to the five major functional areas listed above, the element of location is injected into the C<sup>3</sup>I requirement as a key element.

Interaction with Regional Governments and Peoples. In protracted war this will be perhaps the most demanding C<sup>3</sup>I challenge. Governments and societies throughout the remainder of the world, with the exception perhaps of Western Europe, simply lack the cohesive communications infrastructure necessary for effective control. Theater C<sup>3</sup>I will have the mission of absorbing the slack.

Finally, in newly established theaters, especially where U.S. and allies may project forces in the conduct of protracted war, C<sup>3</sup>I capabilities must be enduring, mobile, and flexible in meeting national needs. This aspect of the problem is addressed in detail in following section.

#### 4-3.2 Retain/Restore Global and Subordinate Military Logistics Structure

The logistics challenges presented under this protracted war scenario are the most demanding that have ever faced logistics planners. Combat arms - the Army, Navy, and Air Force - cannot exist without support forces and supplies to feed, clothe, shelter, arm, equip, maintain, administer, discipline, transport - and control that establishment. Logisticians agree that in a conventional war scenario logistics is a formidable task; in a

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protracted nuclear war its magnitude is practically immeasurable. In this study, we can only identify the essential elements of the problem.

The typical U.S. military service logistics flow system is shown in Figure 4-1. Magnitude, time and logistics movement means are not the only consideration in understanding complex ramifications of the logistics problem. The following are other major considerations.

The Defense Logistics Agency has responsibility for service common military logistics items.

The General Services Administration has responsibility for civilian/military general supply items.

The Army, in some instances, provides massive logistic and administrative support to sister services; they are all interdependent.

In peacetime - and for wartime planning - the "system" relies heavily on air lines of communication.

Virtually the entire administration and inventory control procedure relies on electronic data processing systems.

Against this backdrop of logistics interfaces, the initial nuclear exchange attempted to excise the U.S. war making capability. Military depots became early casualties; the CONUS base in Figure 4-1 was devastated. However, to a large extent the initial attack did not destroy the war sustaining production base. Further, time, a good percentage of depot stocks could probably be salvaged. Consequently, maintenance or restoration of our global and subordinate military logistics falls into three areas:

Reestablishment of overall logistics capabilities,  
Restoration of U.S. homeland logistics structure,  
Redevelopment of theater logistics structure.

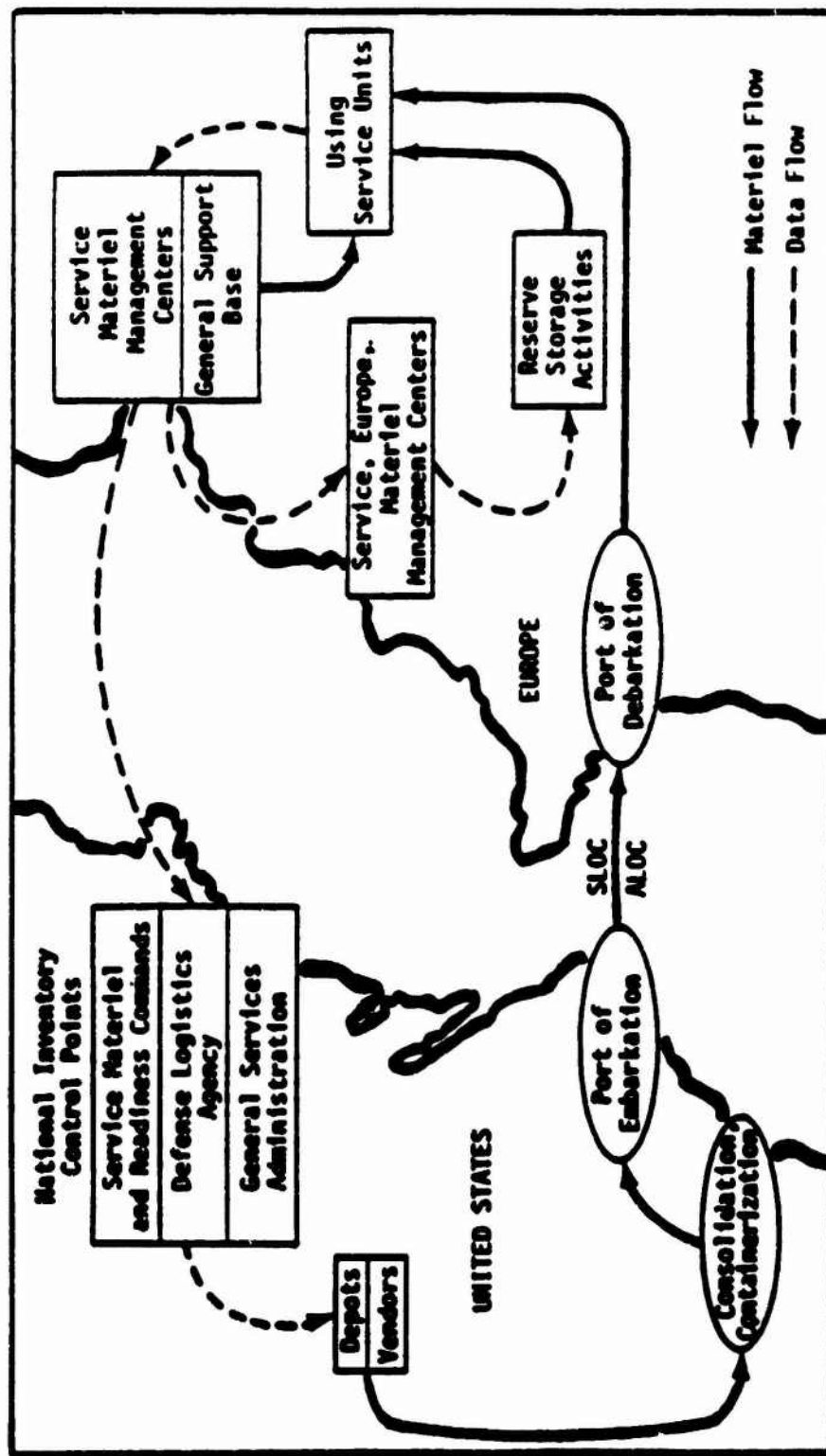


Figure 4-1. Service logistics flow to and from Europe.

#### 4-3.2.1 Reestablish Overall Logistics

Administration. Early restoration of the logistics oriented computer and communications networks should be a first consideration. Multiple, secure storage locations for updated data bases would be of tremendous value in materiel location and refurbishment. A program to assure survivability of a personnel infrastructure would be of benefit.

Inventory. Some of the depot stored equipment will be salvageable; the initial attack will raze the depot storage structures but may not destroy all the contents. Vendor manufacturing capabilities will basically remain intact and be of value in the mid- and far-term recovery. Damaged equipment can be made serviceable by substitution of spare parts and assemblies or by substitution of major items. Storage areas in central city locations can be made available for collection, categorization and processing of militarily important supplies.

Transportation Network and Systems. The linchpin of the American economy has always been its distribution system. That system, like the communications network discussed earlier, has consistently been an early target for reconstitution in local and regional crises.

#### 4-3.2.2 Restore U.S. Homeland Logistics Structure

Depot and Base Logistics. Military reorganization will depend in large part on the success of the functions discussed above. In addition, the distribution and relocation of energy sources, especially petroleum products, will be paramount. Even within the services a highly controlled rationing system will be necessary.

Reserve and National Guard Recovery Teams. The "civilian" army provides an excellent framework upon which to establish the infrastructure for recovery. Because of their location within cities remote from active bases, most of the armories and installations will survive the initial attack relatively unscathed. They provide a depository for frequently updated data bases to initiate logistics recovery. The reservoir of trained personnel with their specialized equipment can and should be trained in the procedures to

[REDACTED]

salvage devastated military bases. These organizations have consistently contributed heavily to local and regional recovery efforts. That experience can be built upon.

#### 4-3.2.3 Develop Theater Logistics Structure

The eventual projection of reconstituted forces to support allies or secure control of critical areas of the world will require the establishment of additional theater logistics capabilities.

Overseas Transportation Networks. Some non-U.S. overseas bases may not be targeted in the initial nuclear exchange and the protracted use of nuclear weapons between the U.S. and Soviet Union. Ports and transshipment facilities must be supplemented by an intratheater transportation network. Host nation support can contribute heavily to these functions. Ships and aircraft of the civilian fleets and surviving military assets will form the nucleus for this function.

Overseas Administrative Links. The logistics structure will require communications and computer networks similar to and compatible with those in Europe and the Pacific theater. The whole operation will be dependent on the reestablishment or replacement of satellite and cable networks.



The concepts of war initiation assumed that the central nuclear exchange will be counter-military with the Soviet Union holding U.S. urban-industrial and population targets hostage. Combat operations will continue for the purpose of the final defeat of the enemy. This probably will involve some form of theater war and possibly an attempt to invade the opponent's territory.


Specifically, riding out and recovering from the initial nuclear exchange is important to the will and resolve of U.S. allies to resist.

Militarily, the U.S. may not lose its in-place fighting strength at the front and at sea. The length of time the conventional war has been underway affects: (1) the degree to which immediate U.S. reinforcements have been deployed in place, (2) the extent to which the U.S. Navy is on the high seas and the U.S. Air Force military airlift (including callup Civil Reserve Air Fleet) is functioning and dispersed, and (3) the adequacy of dispersed logistics stockages in the theaters of operation.

In the military sense, the U.S. has at least temporarily lost its national command and control system (outside the Washington, D.C. area) and its staying power. Against this backdrop, the following major military missions can be identified.

#### 4-4.1 Prevent Loss of Allied Regions (NATO Europe, Japan and Asia)

Politically and militarily, the U.S. must prevent the loss of allied regions. To accomplish this, adequate reinforcements must at least replace losses in key areas over secure lines of communications. The reconstituted and reinforced commands, adequately supplied and with coordinated command and control, must be capable of carrying on combat operations in conjunction with allies.



#### 4-4.1.1 Reinforce EUCOM, PACOM, and Allied Forces

Reinforcement of U.S. overseas major commands will be a first order of military priority. The requirement is to marshall the forces needed, move them to the theater of operations, and locate them where needed.

#### Marshall U.S. Based Forces and Resources

Entering the 1980s, U.S. Ready Reserve Forces allocated to the tactical/mobility function for the three services totals almost 1.2 million personnel. The total force has been relatively constant for the last half of the 1970s and will probably remain so for the 1980s. It constitutes a nucleus of no small magnitude about which recovery forces and the rapid creation of projection forces could be created. These forces may not survive intact if they have been called up and assembled on the bases which the Soviets strike. To ensure their survival fundamental changes in callup and assembly of the Reserves must take place. Marshalling of resources following the nuclear exchange presents a challenge; for the most part (as discussed in section 4-3) it depends upon prior defense procedures preparedness.

#### Provide Overseas Transportation (Air and Sea)

The capability to project forces by air and sea has long been the aim of U.S. defense policy. Reconstitution of the national assets and prioritization of needs will have the flexibility of utilizing the Civil Reserve Air Fleet. Entering the 1980s CRAF consists of some 123 long-range cargo and 250 passenger aircraft. A somewhat depleted military sealift capability in recent years provides additional longer term capabilities to project force. Entering the 1980s four government owned and two dozen chartered dry cargo ships plus 30 tankers are the core of the Military Sealift Command. Over the longer term, the National Defense Reserve Fleet and commercial charters offer the opportunity to augment that capability.

#### Provide Intratheater Transportation and Logistics

At the outset of protracted war, over 200 U.S. tactical airlift aircraft of the C-130 type of the active forces probably became early

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casualties to the nuclear strike. However, a reserve force of some 250 older aircraft, located for the most part on civilian airfields throughout CONUS, probably survived reasonably intact. That force, once deployed, could bolster the intratheater airlift and logistics capability.

#### 4-4.1.2 Establish Control Over Essential Sea and Air Lanes

The Soviet Navy, if it so desired, could mount a massive campaign against U.S. and NATO sea- and air-lines of communications (SLOCs and ALOCs) using attack submarines, aircraft, and (to a lesser degree) surface ships, many armed with cruise missiles. A sizable part of their forces, however, seem committed to security for SLBMs, with attempts to sink U.S. counterparts as a secondary task. The timing and intensity of Soviet anti-LOC attacks is therefore subject to considerable speculation. Strong early assaults by the Soviets on SLOCs would weaken Soviet strategic defense of the homeland to some uncertain degree under general war conditions.

The U.S. and its allies must, through combined efforts, establish and keep open the LOCs to Europe. SLOCs are eventually a necessity. ALOCs can be helped by the geography of mutual cooperation. For example, the ALOC from the U.S. to Europe via Lajes, Spain or Portugal, and France would be inherently more secure than that of the North Atlantic route. The loss of Iceland would pose a most difficult problem in defending the North Atlantic sea and air routes.

#### 4-4.1.3 Conduct Combat Operations

The single most cohesive element to maintaining allied solidarity would be visible success on the battlefield. This holds for general war as well as nuclear war.



## Defeat or Repulse Invading Forces

Modern forces in place, adequate in numbers to the task, and properly instilled with the will to fight are the key to success in battle. This is the final touchstone of an alliance. It depends, in large part, on the moral fiber of each soldier, airman, and sailor - his sense of destiny and that of his family, community and nation.

The key national military mission is to ensure that each soldier feels this.

The years of preparation for the defense of our allies will assist in providing much of the wherewithal to defeat or repulse invading forces, even following a devastating nuclear attack.

## Initiate Offensives

Offensive warfare - even at the small unit, individual level - breeds success. a military force may be compelled initially to resort to the defensive for a host of reasons. However, commanders must be able to create the atmosphere for offensive strikes. Through the offensive, wars are won. Not the least of the factors which would limit the ability to seize the initiative is the assurance of an adequate supply of ammunition and materiel.

## Air Defense and Sea Denial

Air defense of the population and sea denial of contiguous waters are two visible manifestations of military success to a population. Modern sea forces, like population centers, can survive only if they live under an umbrella of air defense. Air defense is a measure of offensive capability; if successful, it permits the conduct of other forms of warfare, land, sea and air.

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4-4.1.4 Provide C<sup>3</sup>I and Logistics

Section 4-3 discusses the aspects of U.S. national C<sup>3</sup>I and logistics considerations in protracted war. Of equal consideration is the ability of allies to achieve the military compatibility of these vital functions in concert.

With NATO, and to a less structured degree, with U.S. alliances vis-a-vis Japan, Korea and other Asian nations, Rationalization, Standardization and Interoperability (RSI) of military forces is a prime military mission. Success of RSI is not a phenomenon that can be measured finitely or result from any one program. However, it is a military mission. Equipping, training and structuring military forces to operate together as allies will prevent the loss of those vital areas in a protracted war.

4-4.2 Take Control Over Critical Regions

Many regions of the world will remain strategically important to the U.S. following the initiation of a nuclear conflict. Some areas, such as Iceland or the Panama Canal will remain important for reasons of strategic location: they contribute to airspace and sea control. Others, such as the Middle East and Africa will maintain their importance because of strategic resources. Many of these areas now have Soviet bases or lie within striking distance of Soviet military forces.

Consequently the U.S. will be faced with the need to identify those critical areas and project forces to control them. While it is not the purpose of this study to analyze or develop a probable national strategic scenario, it is within the purview of analysis to discuss the essential military tasks and missions.

The military missions identified are not dissimilar to those facing defense planners of the 1980s. As national military recovery from the initial nuclear strike matures, military planners will need to marshal projection

[REDACTED]

forces (from competing resources), place them in accordance with national priorities, conduct combat operations, and provide C<sup>3</sup> and logistic support.

#### 4-4.2.1 Marshall U.S. Projection Forces

##### Assemble Forces and Resources

A key to recovery and reconstitution of U.S. military forces will be the organization of defense manpower. U.S. armed forces try to keep careful statistics concerning respective manpower levels. All sorts of activities and administrative actions depend on such lists; pay and allowances, construction, clothing and personal equipment and medical support are representative. Reserve components and civilians, as well as uniformed regulars, are taken into account. It is from this host of manpower sources, the majority of which are found in the U.S. Ready Reserves, National Guard, and the Individual Ready Reserves, that mobilization of projection forces will rely. The manpower mobilization structure deserves peacetime emphasis to cope with the demands of a protracted nuclear war.

Resources for projection forces will depend heavily on the recovery of logistics stocks following the nuclear exchange. U.S. commanders of standing and deployed forces realize they will have to fight the next war with the materiel and stockages "on hand." It is highly unlikely that the military production and distribution base will be able to gear to the needs of a conflict. Similarly, reconstitution of logistic support for projection forces will depend heavily on a mammoth salvage effort. Dispersion of war materiel reserves stocks in peacetime would pay outstanding dividends in the protracted war environment.

##### Assemble Transport

Assembly of transport for projection forces poses complex problems in marshalling the resources needed. Fuel for long range projection of force by air would more than likely not be available in the quantities required, as well as the airlift resources. Sea transportation relying on privately-owned U.S. shipping dedicated to the Sealift Readiness Program appears as a feasible

[REDACTED]

alternate solution. Additionally, requisition or even confiscation of ships sailing under flags of convenience offer additional resources.

Finally, the need for dispersion in assembly of projection forces adds to complexity of the problem. In this scenario the objective of the nuclear attack was to excise the U.S. capability to conduct military operations. Any large scale assembly of reconstituted forces would most certainly cause a revisit of nuclear strikes by the Soviets.

#### 4-4.2.2 Projection Forces

Movement of projection forces poses problems similar to those facing the U.S. in developing rapid deployment forces with two exceptions. First will be the necessity to place emphasis on sea transportation as opposed to air transportation. Second will be the naval counterforce capability of the Soviet Union; the Soviet Navy probably will experience considerable loss/damage incapacitation. Nevertheless, it will retain formidable capability to disrupt sea movement of projection forces.

#### 4-4.2.3 Conduct Combat Operations

The pace and tempo of combat operations would not appear to demand a new set of military expertise. Overall force mission requirements for critical area control and the prevention or ejection of Soviet intrusion remain the most likely objectives. Because the nuclear threshold has been crossed on the strategic level the likelihood of tactical nuclear war is heightened. Consequently, obtaining local support for military thrusts could be a problem. Some form of political or economic leverage, or outright coercion, might be required to gain essential support.

#### 4-4.2.4 Provide C<sup>3</sup>I and Local Logistic Support

The requirements for C<sup>3</sup>I will remain a constant in the scenario for protracted nuclear war; only the resources available for effective measures may impose a greater risk in force projection operations. It is likely that greater reliance need be placed on logistics procurement and support at the local level than that to which U.S. commanders now seem prone to accept.

Fundamentally, U.S. military missions would remain unchanged in a protracted war. To resolve the conflict in favor of the U.S. would be the overriding objective. Only in effort, emphasis, timing, and perhaps operational techniques would there be differences. Basic military missions essential to national survival are the maintenance of forces for strategic strike capability and therefore protection of the homeland. The need to sort out and reconstitute the CONUS logistical base is perhaps the most demanding requirement identified. This is followed closely by reconstituting a responsive worldwide C<sup>3</sup>I capability. Loss of space based assets is critically damaging and difficult to overcome. Last, the ability to project force to critical areas and to achieve early successes, both for the U.S. and its allies, appears especially critical.

Trained military personnel will prove to be the most valuable asset to the U.S. Successful post attack military missions will not be possible if the hard core of American troops is lost in the early phase of the nuclear attack. Survival of sufficient active duty personnel to cadre the recovery and reconstitution effort is absolutely essential. Today they are vulnerable, even with early warning of attack. Programs on a national scale to enhance standing force survival should receive the highest priority.

The preceding discussions of military missions in a protracted war have one common thread: reliance on reserves. Retention of organized manpower is paramount. Plans for development and employment of Reserve Units, National Guard and the Individual Ready Reserves should rely on the organizational structure inherent in the reserve system. The dispersion of the armories and encampments enhances their survival. Improved facilities, training and proficiency can provide endurance. A major program aimed at preparing Ready Reserves for the advent of protracted nuclear war is needed.

Examination of protracted war emphasizes the need for "prior planning" which preserves flexibility. Over the years the national military policy has been to 'streamline' the broad structure of the CONUS and overseas military bases. This has been done in the name of efficiency and economy. Installation consolidation and base closing has greatly reduced the number of



[REDACTED]

military targets that need to be attacked to excise the U.S. defense capability should the Soviets desire to do so. U.S. military planners are constrained by having small standing forces and must also recognize that a broad base of military experience is lacking on a national scale. Programs should be developed to thwart the impact of a successful nuclear attack on the U.S. military structure. Planning should modify the capabilities and characteristics of our military and civil communities so that the impact of a demilitarizing nuclear attack will be lessened.

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[REDACTED]

## SECTION 5

### SYSTEMS AND CONCEPTS FOR ENHANCED U.S. CAPABILITY FOR PROTRACTED WAR

5-1

[REDACTED] **APPROACH AND SCOPE**

[REDACTED] The previous two chapters addressed the probable initial conditions and environment of a protracted war (Section 3) and the military missions which would have to be carried out by U.S. forces to satisfactorily resolve the conflict (section 4). From an assessment of the initial conditions it becomes apparent that U.S. forces will probably not be in adequate condition to permit fighting a protracted war, i.e., to carry out adequately the prescribed missions. This section addresses a number of conceptual ideas whose implementation would enhance U.S. capability to execute the prescribed military missions and functions. In most instances the presented ideas do not offer complete solutions but rather represent steps in the direction of adequate protracted warfare capability.

[REDACTED] In the past, most U.S. theoretical studies of strategic nuclear warfare have not considered the question of extended survivability of weapons and delivery vehicles not expended in an initial exchange in which escalation control is a dominant requirement. It is not reasonable to expect our military leaders to control escalation when we have given them forces such that a conflict must be escalated or the forces lost, i.e., weapons not needed or not useful in a counterforce exchange must be used for countervalue (escalatory) strikes or lost because they lack retainability. The capability to control escalation must be designed into the forces; it cannot be provided as an afterthought. The key to controlling escalation is to build forces that can be retained without their becoming attractive targets for Soviet follow-on attacks.

[REDACTED]

[REDACTED]

[REDACTED] Soviet forces, by contrast, include systems and operational concepts which will support their military doctrine of "fighting on" until the enemy is vanquished. For their bomber forces these concepts include the planning and preparation for restoring damaged runways to use as well as the use of "Field Air Bases" (auxiliary airfields) including the use of grass airfields.<sup>(1)(2)\*</sup>

[REDACTED] These efforts provide Soviet Air Forces with a means of achieving retainability — a retainability which U.S. systems do not possess.

[REDACTED] In preparing the groundwork to provide adequate survivability/endurability for military systems and functions in a post nuclear exchange environment a wide range of problems must be dealt with. For some problems direct single-stage solutions can be devised. The deep-basing concept for providing post-exchange ICBM (and perhaps other types of) capability is an example of a single-stage solution in that the full operational capability is in place and ready to perform when called upon. In other cases, multi-stage solutions may be the most suitable, perhaps the only, solutions feasible. A multi-stage solution is one in which, starting perhaps at a very rudimentary level, capability at each stage generates a higher level capability and the desired end-product capability is achieved ultimately by progression through a number of stages. For example, a solution may call for a few men on foot with simple, therefore readily made survivable, equipment to locate and prepare one or two transport vehicles, perhaps helicopters, to be used to bring together more men, vehicles, equipment, and supplies which in turn can build into an infrastructure to recover, restore, support and/or operate some particular weapon system.

\* Numbers in parenthesis refer to list of references.

As discussed in Section 4-2.1 the U.S. must retain adequate strategic strike capability to attack targets as appropriate and to deter/coerce adversaries and other nations as well during the postexchange protracted warfare period. The primary focus in this section is on approaches to enduring survivability for weapon delivery systems. For protracted warfare operations these systems will, of course, require C<sup>3</sup>I and logistical support.

It is difficult to conceive of a system which is absolutely retainable (undestroyable). Adequate retainability, however, can be achieved by making a system so difficult to attack that a potential attacker would decide it was not worth the effort. For developing quantitative data the criterion that the Equivalent Weapons (EW)\* value of forces expended should be at least equal to the Equivalent Weapons value of forces destroyed is often used. Other criteria, however, may be more appropriate under particular circumstances.

#### 5-2.1 Retainable Bomber Concepts

By virtue of its mission flexibility (including reconnaissance) the intercontinental bomber is highly desirable as part of the required protracted warfare strike capability. Retainability, however, is not easy to achieve; [REDACTED] Several approaches to providing retainability for future strategic aircraft systems are examined here.

During a protracted warfare period strategic aircraft will be on the ground most of the time. Airborne alerts can be sustained only for periods very short compared with a protracted warfare period of months or years. This, coupled with the fact that the EW value of a bomber is very large compared with the EW value of an SLBM or ICBM RV indicates clearly that

\* See Appendix B for definition of EW

[REDACTED]

a bomber system cannot be preserved if the adversary knows where each aircraft is located. (Even silo level hardening could not protect aircraft known to be at particular locations.) Clearly then the adversary must be denied location knowledge. The following material includes several approaches for accomplishing this.

[REDACTED] A major factor in U.S. bomber endurance is that, unlike the Soviet Backfire force, current U.S. bombers are dependent upon the availability of long, wide runways for takeoff when fully loaded. At present the number of such fields in the United States is small enough to make it worthwhile for the Soviets to attack these bases and deny their continued use. If, however, the number of airfields at which U.S. bombers were capable of recovering could be significantly increased, a point would be reached where the Soviets would use more weapon value in their airbase attacks than the target value they would destroy.

[REDACTED] Present day U.S. bombers which are not used in an immediate counter-military exchange can extend the number of fields they could use by landing extremely light without weapons and with little fuel on board. While these runways would only permit takeoff in a lightly loaded condition, the bombers could be staged through a repaired runway for weapon and fuel on-load prior to a long range mission. Whereas adopting this concept would permit the present bomber force (without modification) to operate from several hundred more runways than currently available (and hence reduce its vulnerability to follow-on attack), [REDACTED]

[REDACTED]

[REDACTED] There is substantial evidence that the Soviets have a capability to repair runways damaged in a nuclear conflict. This permits them to "store" reserve bombers at a very large number of dispersed, short runways. (By reducing the on-board fuel the runway length needed for both landing and takeoff can be greatly reduced.) They can fly these planes back to repaired longer runways for refueling (and weapon on-loading if required) just before dispatching them on missions against U.S. or other long-range targets.

[REDACTED]

Substantial advantage can be gained by the U.S. if new bombers are made capable of performing standoff missions using long range cruise missiles and without refueling still be capable of returning to the continental U.S. If the aircraft operating characteristics are properly designed, the number of useable fields available can be made sufficiently large to make the dispersed bombers an unattractive target.\*

As noted, extremely short field dispersal concepts may require the use of longer runways for full load takeoffs needed with long range (inter-continental) missions. Hence such measures taken to insure retainability of the current bomber force will not be meaningful unless a capability to repair, restore and substitute a sufficient number of long runways for mission use can be provided. Measures to implement this are discussed in Section 5-2.4. A substitute for runway repair would be the development of aircraft capable of off-runway operation on gravel, grass, or minimally-prepared fields.

Concepts which provide for dispersal to short fields with or without down-loading must also provide for survivable weapons and fuel storage. This is best achieved by a combination of dispersal, underground storage and hardening which makes the opponent's weapons requirements for destruction unattractive when compared with the value destroyed. These measures are discussed in Section 5-2.1.5.

#### 5-2.1.1 [REDACTED] Dispersal and Concealment

This approach envisions using existing airfields plus new expedient airfields to provide an adequate level of dispersal. The total number of fields required is many thousands; the actual number depends on the magnitude of the bomber force to be retained, on the weapons available to an attacker, and on the criterion chosen for "adequate retainability." As an illustration

\* This assumes that the U.S. would deny the Soviets near-time reconnaissance, or would move aircraft from field to field on a cycle which would prevent their locations from becoming known well enough for effective targeting.

[REDACTED]

consider that a force of 100 bombers with 24 ALCM each is to be made retainable. The EW value of an ALCM is about 0.56 so the bomber force represents 1540 EW. If the average EW value of Soviet RVs potentially attacking the bomber force were 0.28 (half the ALCM value), the criterion stated above would require at least 48 RV's/48 airfields per bomber or a total of 4800 airfields in order for the force of 100 bombers to be retainable.\*

[REDACTED] Note that the number of fields required is proportional to the value of the aircraft force to be retained. In the above example 4800 fields were required to provide retainability for a bomber force with value 1540 EW. The desired level of post-exchange bomber strength is probably substantially higher than this and the required number of fields would be correspondingly higher.

[REDACTED] Figure 5-1 indicates numbers of existing airfields for various LCN's and runway lengths. Even with aircraft requiring low LCN and runway length, the total number of CONUS airfields of all types is too small to provide retainability for such bomber forces and construction of additional fields will be necessary. One solution, of course, is to provide the required additional number of expedient dispersal fields. These need be capable only of supporting the aircraft for a moderate number of takeoffs and landings and can be constructed relatively inexpensively if the aircraft is designed for low LCN and short runway lengths. Table 5-1 describes a representative expedient dispersal field. Each dispersal field must provide means of concealment for the aircraft. Presumably attempts will be made to suppress enemy space and airborne platform surveillance; nevertheless, it would appear to be too risky to leave the aircraft at the same location unconcealed for a substantial period of time.

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\* This illustration serves to indicate the order of magnitude of the retainability problem. As mentioned earlier, criteria other than the one used may be more appropriate. Among other considerations not examined here is that the Soviet ICBM/SLBM payloads could be optimized (fractionated) for this type of an attack.

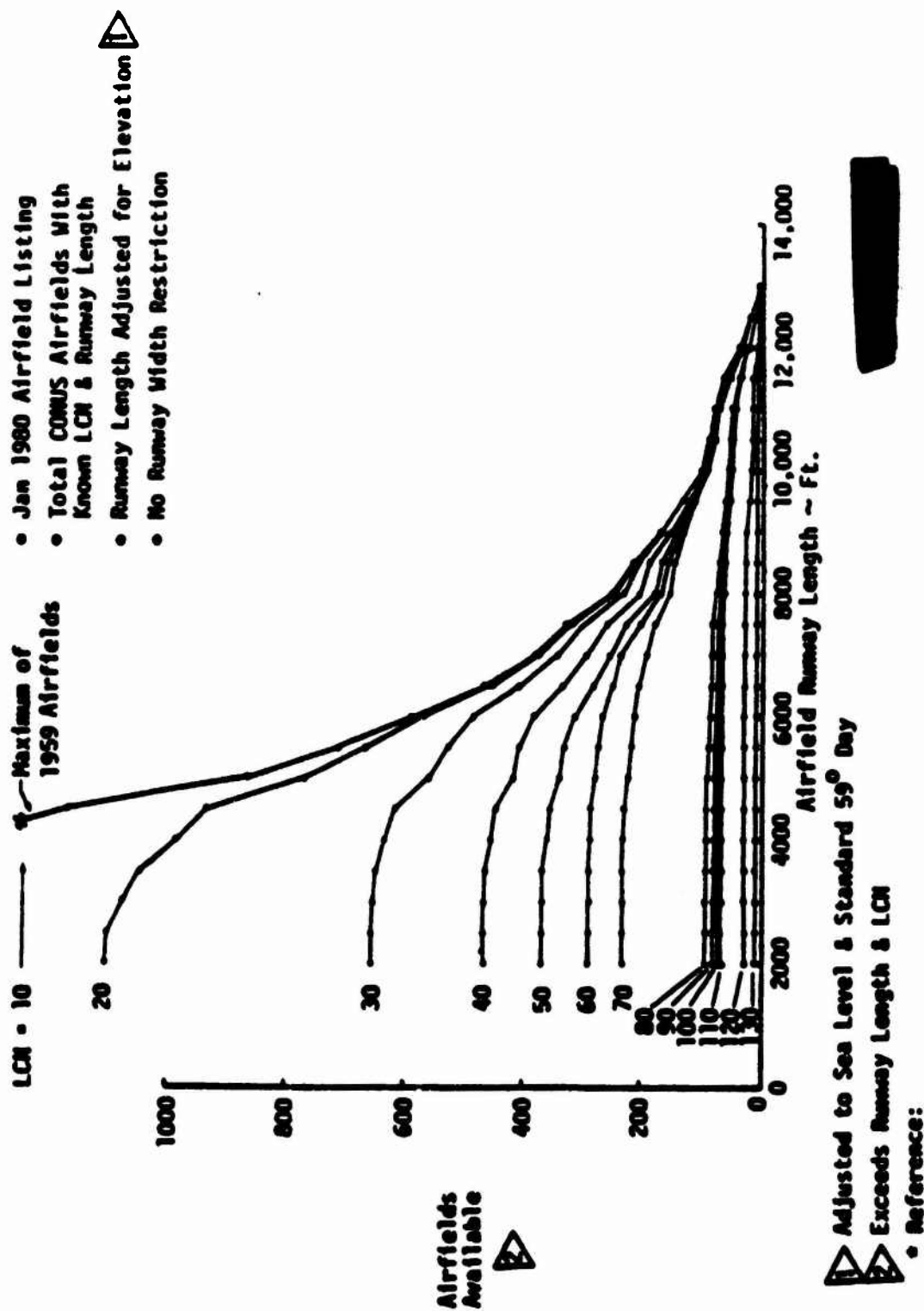


Figure 5-1. Existing CONUS airfields.  
(Military + Civil + Joint Use Airfields)\*



Table 5-1. Cost of an expedient 4000' runway base.

<u>COST CATEGORIES</u>	MILLIONS OF FY 1980 DOLLARS			
	IMPROVEMENT (CHANGES TO EXISTING):			
	<u>CONCRETE</u>	<u>ASPHALT</u>	<u>GRAVEL</u>	<u>NEW</u>
Environmental Statement	-	-	-	.10
Concealment Hangar	.38	.38	.38	.38
Site Preparation	-	-	.06	.24
Drainage	-	-	-	.10
Gravel Runway	-	-	.20	.50
All Weather Landing System	.16	.16	.16	.16
Emergency Generator	-	-	.10	.10
Lighting	-	-	-	.24
Fences, Security	-	-	.25	.25
Total	<u>.54</u>	<u>.54</u>	<u>1.39</u>	<u>2.07</u>

Hardening does not appear to make a significant contribution to retainability. Hardness levels much above about 25 psi would require great complexity and cost, and at 25 psi a relatively small nuclear warhead detonated at the midpoint of a 4000 ft. runway would destroy shelters and aircraft at the ends of the runway. Hardening against sabotage presumably is achievable and should be provided.

Ideally the aircraft should be able to utilize the dispersal fields fully loaded with fuel and weapons. If not, a multi-stage process such as that described in 5-2.1.2 would be necessary to launch the aircraft on full-scale missions. Each dispersal field will provide a relatively modest level of fuel and other necessary supplies.

Maintenance and repair cannot depend on centralized facilities at a small number of bases because these would certainly be attacked but, instead, must be provided to some substantial degree by personnel traveling with the aircraft plus parts and supplies located at many or all of the dispersal

[REDACTED]

fields. Parts, equipment, and expertise required in some instances but not provided by such arrangements must reside in some adequately survivable configuration and be provided with means of transportation to rendezvous with aircraft to be serviced. Crosstraining of combat crews for maintenance and repair will minimize the number of personnel required.

[REDACTED] For at least several years, technology has been available to develop and build dual purpose bombers with significant potential for retainability. Such aircraft would be capable unrefueled of round-trip standoff missions and of penetration missions with recovery to points outside the Soviet Union. Given adequate retainability measures, such a system should be capable of multiple standoff missions. More than one penetration mission, however, would be difficult, either because the recovery bases in non-U.S. territories would be attacked, or because refueling would be denied for fear of Soviet reprisal. The penetration missions will, of course, probably experience substantially greater air defense attrition than the standoff missions.

[REDACTED] The dual-purpose bombers referred to are of conventional jet-powered subsonic design. Among Boeing Company preliminary designs in the past have been aircraft capable of delivering 28 ALCM on a 4000 n.mi. radius standoff mission and capable of taking off and landing fully loaded on 4000 ft. runways.

[REDACTED] Penetration capabilities of such aircraft would be substantially improved over those of present heavy bomber aircraft but not be as good as stealth technology could provide. A combination of stealth and STOL characteristics would be very desirable in a protracted warfare bomber.

#### 5-2.1.2 [REDACTED] All Surface Takeoff and Landing (ASTOL) Concept

[REDACTED] Aircraft system retainability may be provided by all-surface take-off and landing (ASTOL) capability. Clearly if an aircraft can land on any surface sufficiently long and free of obstructions, it can utilize for survivability/retainability a huge number of already existing or easily prepared locations, such as farmlands, deserts, beaches, dry lake beds, sections of highways, etc. Retainability, of course, requires aircraft locations to be

[REDACTED]

unknown to the potential attacker. Without natural or manmade concealment, aircraft retainability would depend on inability of enemy surveillance systems to ferret out and adequately observe all or most possible locations within CONUS. Whether space and/or airborne surveillance systems will have and retain this capability or can be reconstituted to achieve it may be a decisive factor in the outcome of the war. (See Section 3-4.3)

[REDACTED] If periodic relocation is required during the protracted warfare period, then fuel and other supplies must be made available. These supplies must therefore reside at many dispersed locations, comparable in number to the number of expedient fields discussed in section 5-2.1.1. Either the necessary supplies must be brought to the aircraft by an auxiliary survivable transportation system (e.g., trucks or helicopters) or there must be suitable landing and takeoff "fields" provided at the supply locations. Either way, then there would be little to distinguish the ASTOL concept from the dispersal/concealment concept of 5-2.1.1. The greatest advantage from ASTOL capability would be realized only if no significant movements were required of the aircraft prior to its dispatch on a mission. Note that continuing missions also would require the mechanisms for resupply.

[REDACTED] The preceding discussion of the ASTOL concept presumes that the aircraft can operate fully loaded from its many stations. If not, it would be necessary to use an approach similar to that discussed in 5-2.1.3 for launching aircraft on missions.

#### 5-2.1.3 [REDACTED] Off-loaded Operations

[REDACTED] Off-loading weapons and fuel is one approach to being able to utilize enough dispersal locations for (ASTOL or conventional) aircraft retainability. To conduct an intercontinental range mission, then, the aircraft must first move to a location permitting fully loaded takeoff and acquire the necessary weapons and fuel. Unless there are many thousands of such locations, they will be attacked; if the adversary knows any such location has been restored, it will be attacked again. Thus the feasibility of the off-loading approach depends on whether restoration plus aircraft turn-around can

[REDACTED]

be accomplished before the potential attacker makes another strike. Restoration of runways is addressed in Section 5-2.1.4.

[REDACTED] Even if enemy surveillance is totally denied, he may conduct periodic attacks to prevent the use of these mission-launch locations unless the total number of such locations in combination with the restoration time makes repeated attacks too costly.

[REDACTED] It is clear that aircraft systems intended for protracted war situations and requiring off-loading for survivability/retainability should be designed to use readily restorable launch surfaces.

#### 5-2.1.4 [REDACTED] Runway Restoration

[REDACTED] This section examines the mechanisms for and probabilities of damaging runways to prevent their continued use and the time and feasibility of restoring or substituting for damaged runways. It involves operational concepts, repair techniques, and logistical preparations not currently in use or planned for by U.S. forces.

#### [REDACTED] Runway Denial

[REDACTED] A review of the principal damage mechanisms to runways to nuclear weapons is in order prior to discussing repair techniques. Runway denial by nuclear weapons may result from craters in the runway, pavement breakage in the rupture zone outside the crater, deep piles of debris thrown out of the crater, scattered rocks and boulders far from the crater, and radioactive fallout. While there are many variables and uncertainties involved in quantifying nuclear weapon effects, the principal damage mechanisms which result from cratering, runway rupture, debris throwout and fallout are known well enough to make reasonable estimates of probable damage. A runway itself is a very hard target\* so a highly accurate weapon must be used against it in order

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\* [REDACTED] The rupture zone extending to 1-1/2 crater radii will break and dislocate the runway surface and is the outer limit of damage to the runway itself. The edge of the rupture zone corresponds to an overpressure of 4,000 to 8,000 psi depending on soil type. This is a distance of 750 to 950 feet from a 1 MT surface burst and 275 to 350 feet from a 50 KT surface burst.

[REDACTED]

to obtain a high probability of damage. Other elements of an airfield (parked aircraft, hangars, maintenance building, POL storage, vehicles, living areas) are soft targets\*\* with large damage radii\*\*\* and can be attacked with relatively inaccurate weapons. Effective destruction of a runway requires that the pavement be destroyed, i.e., ruptured or removed by cratering. The concepts of prolonged war initiation developed in Section 3-3 assumed airbursts on most military targets.

■ Surface bursts are required for long-term runway denial by cratering, rupture, massive debris, and intense fallout. Cratering and rupture provide the longest denial periods, but since the radius of the crater and adjacent rupture zone are comparable to or sometimes smaller than the CEP\*\*\*\* of many of the weapons in today's arsenals, there is a significant probability that the weapon will not detonate close enough to the runway to crater or rupture it. In this study several weapons were examined (based on their accuracies and yields) for analysis of probability of runway damage. These consist of a MIRVed SS-18 of the late 1980's, an aircraft delivered weapon (ALCM) and (briefly) 2 SLBM types (Poseidon and Trident I). The yield/accuracy spectrum of these weapons is considered broad enough to provide insight into the capabilities of various weapon types for cratering or rupturing a runway. (Although Soviet attacks on U.S. runways are of most interest in this study, the calculations will be extended to U.S. attacks on Backfire-capable airfields.)

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\*\* ■ Targets which can be destroyed by overpressures of 10 psi or less. 10 psi is often used as a conservative damage criterion for soft targets such as vehicles and buildings, although most light frame buildings are destroyed by only 5 psi.

\*\*\* ■ A 50 KT weapon airburst at the optimum height or burst to maximize 10 psi has a 10 psi radius of 5340 feet. A surface burst 50 KT weapon has a 10 psi radius of 3800 feet.

\*\*\*\* ■ CEP is the radius around the aimpoint within which one half the weapons not scored as reliability failures will fall.

[REDACTED]

Runway requirements for the aircraft of interest will be covered in the next section. This section covers the sensitivity of the probability of interdicting (cratering or rupturing) a runway to weapon yield and CEP. As a specific example, consider the probability,  $P_I$ , of interdicting a runway 8000 ft. long and 280 ft. wide in such a way that no undamaged segment longer than 4000 ft. remains. Table 5-2 shows  $P_I$  for various weapons. Note that  $P_I$  is [REDACTED] and near zero for the low yield SLBM RV's. Because of this very low probability, SLBM's will be dropped from further consideration. [REDACTED]

[REDACTED] Table 5-2. Sensitivity of interdiction probability to weapon parameters.

WEAPON	$P_I$	REMARKS
POSEIDON RV	.10	KT YIELD, LARGE CEP
IMPROVED TRIDENT C-4 RV	0.10	KT YIELD, SMALL CEP
[REDACTED]		

[REDACTED] The crater radius for a 1 MT surface burst varies from 390 to 650 feet depending on soil conditions. Figure 5-2 depicts a 1 MT crater on a typical airfield situated in dry soil (480 ft. crater radius). The rupture zone in which runway pavement will be broken and shifted extends to 1-1/2 times the crater radius. Heavy debris, which will require at least several days of bulldozer operation to remove, extends to 2 or 3 times the crater radius. Heavy debris thus provides the greatest potential for long-term runway denial. Debris is not deposited symmetrically around the crater but is ejected in "rays" similar to the rays observed from lunar craters. "Average" debris depths are obtained by averaging the depth which occurs at a selected radius from the burst center. "Average" depths are useful for calculating the volume of material to be removed in restoring a runway. Scattered debris, sufficient to preclude safe runway use until it is removed occurs out to about 10 crater radii.



Figure 5-2. Schematic view of cratered runway.

[REDACTED]

Fallout covers a larger area than other runway denial effects and may extend from tens to hundreds of miles downwind from the burst point. Fallout radiation intensities can be great enough during the first several hours to prevent any activity except an emergency dash by the crew of a landing (or taking off) aircraft between the aircraft and a personnel shelter. Fallout intensity decays rapidly so that refueling is possible after 24 hours and limited maintenance after 48 hours. At the end of the week most maintenance activities can be conducted using rigorous control of personnel exposures. Fallout can delay removal of scattered debris from a runway until the intensity has decreased enough to permit acceptable exposure of the work crews. Only after nearly 24 hours can work crews be safely exposed for one hour in heavy fallout areas, thus debris removal before that time is not practical. For the same reason runways which escaped massive damage by cratering but which received debris and fallout from near misses could still be unsafe for landing by aircraft which initially escaped by fast flush take-off. (See also the discussion in Section 3-4.2.3 regarding the effects of volcanic ash on runway use and presumed similarity to fallout.)

[REDACTED]

The projected accuracies and yields of USSR missiles are such that there is considerable probability that many runways will escape massive damage by cratering or deep debris unless multiple weapons are used (see Table 5-2). However, scattered debris from surface burst USSR weapons extends to several times the projected USSR missile CEP's so there is only a very small probability of escape from scattered debris unless the weapon fails to detonate. Short-term denial (on the order of 24 hours) is therefore much easier to achieve than long-term denial. Even short-term denial is difficult to achieve if the defender has a large number of runways suitable for emergency empty weight landings and takeoffs. As an example, suppose the defender needs 10 clear runways for emergency landing capability and the attacker has 80% overall system reliability. If the defender has 50 runways, the attacker needs only one surface burst targeted against each to keep the surviving clear runways to 10 (expected). If the defender has 250 runways, then the attacker must target 2 surface bursts against each one, and for 1250 runways he must target 3 surface bursts against each. The number of attacking warheads for runway denial thus increases rapidly as the number of target runways increases. This becomes a dubious use of warheads for the attacker since the



[REDACTED]

defender may be able to land all of his aircraft if only one or two runways remain clear. Also, the defender could use remote controlled equipment to clear runways of scattered debris. The U.S. has developed remote control capability for several types of runway clearing sweepers, scrapers, and bulldozers and could build and stockpile such equipment whenever desired.

[REDACTED]

[REDACTED]

[REDACTED] Burst heights can be low enough for surface dust mixing with the fireball to produce essentially the same fallout as a surface burst and yet be too high to produce an excavated crater and crater originated debris. There is little diminution of fallout unless burst heights exceed a scaled height\* of 100 feet while a scaled burst height of only 20 feet essentially eliminates the excavated crater. Instead of an excavated crater, there may be a compression crater due to soil compaction by high overpressures directly below the burst point. There will be random debris from blast wave destruction and scattering of structures, equipment, and vehicles but the volume of this random debris is small compared to the volume excavated from a surface contact burst crater and cannot be relied upon for runway denial. The fallout from such a burst will be intense enough to prevent runway clearing (except by remote control equipment) for about 24 hours so there may be cases in which

\* Scaled height of burst is defined as:  $\frac{\text{Actual height of burst}}{(W)^{1/3}}$

Thus, if  $h_0$  is the height of burst at which a particular overpressure occurs at ground zero from a 1 KT explosion, then for an explosion of  $W$  kilotons energy, the same overpressure will result from a height of burst  $h$ , where  $h = h_0 \times (W)^{1/3}$

[REDACTED]

building or vehicle debris clutter a runway, and the runway cannot be cleared for safe landing by fast flush aircraft until 24 hours or more after the attack. It is possible, however, that blast generated debris will not clutter a runway sufficiently to preclude safe usage. So without a surface contact burst low yield SLBM weapons have little capability for runway destruction or denial. If a weapon is designed for runway denial, it is assumed that a suitable fuzing system will be employed so the burst height will be close enough to the surface to produce cratering and crater ejected debris. In calculating crater volumes and debris volumes for crater filling or debris removal operations, this study assumed that bursts were at the ground surface.

### Runway Requirements

Two U.S. strategic aircraft, the B-52 and the retainable bomber discussed in Section 5-2.1, were considered in this study. ALCM attacks on Backfire airfields were included for comparison. Table 5-3 lists required runway dimensions and number of airfields currently suitable for fully loaded operation of these aircraft. Runway requirements are defined in Section 4.2 of Ref. 2. Note in Table 5-3 that if conditions are such that B-52 outriggers are not needed, considerably more airfields are suitable. However, the number is still an order of magnitude less than those which are suitable for the retainable bomber designed for short field operation.

Table 5-3. Currently suitable airfields for fully loaded operation.

AIRCRAFT	REQUIRED RUNWAY DIMENSIONS		NUMBERS OF AIRFIELDS WITH SUITABLE RUNWAYS
	LENGTHS, FEET	WIDTH, FEET	
1. B-52	≥ 7400	≥ 170	110 196 (193 at LCN 65, No width restr.)
	≥ 7400	≥ 150 *	1926 (1926 at LCN 0, No width restr.)
2. Retainable Bomber	≥ 4000	≥ 100	
3. BACKFIRE	≥ 5000	≥ 100	512 (USSR) (512 No width restr.)
* Acceptable width if outriggers not needed.			

Table 5-4 lists the number of airfields which would be suitable for minimum load (both minimum fuel and weapon load) operations for dispersed survival. This allows operations from hundreds (B-52) or thousands of additional runways and greatly increases the difficulty of an attacker's achieving runway denial. When not engaged in strike missions, the aircraft could be concealed or moved from one field to another on a cycle which prevents their locations being determined well enough for effective targeting. The aircraft would be staged to surviving or restored long runways for weapon loading and fueling when needed for strike missions.

Table 5-4. Currently suitable airfields for minimum load operation.

AIRCRAFT	REQUIRED RUNWAY DIMENSIONS		NUMBERS OF AIRFIELDS WITH SUITABLE RUNWAYS
	LENGTHS, FEET	WIDTH, FEET	
1. B-52 *	≥ 4400	≥ 170	155
	≥ 4400	≥ 150	458 449 @ LCN ≥ 40
2. Retainable Bomber	≥ 2500 <sup>1</sup>	≥ 100	6720 6720 @ LCN ≥ 0
<sup>1</sup> Estimated * Loaded with weapons +1000 n.m. of fuel; LCN = 39 (emergency); length = 4400			

Consider the case of the fully loaded retainable bomber which requires runways 4000 ft. or longer. A majority of airfields with these runways have more than one runway over 4000 feet. The majority also have taxiways over 4000 ft. long. Maps (Ref. 5) of 184 of the 1779 airports in the 48 contiguous states with runways of 4000 feet or more were examined to determine the total number of runways and taxiways that could be suitable for 4000 foot takeoffs or landings. The 184 airports had a total of 371 runways and 219 taxiways over 4000 feet in length for 590 potential runways. Some of the runways and taxiways were close together so that two might be damaged by a single burst. Assuming perfect accuracy, 475 1 MT weapon detonations would crater or rupture the 590 potential 4000 foot runways. Extrapolating from the 184 airports examined to the 1779 listed with 4000 foot (or longer) runways

[REDACTED]

gives a total of 5700 potential runways which could be cratered or ruptured by 4590 detonations. If the overall attack system reliability is 80%, an attack by two warheads per airfield would leave 228 potential runways, more than enough to serve as landing fields and shuttle fields for an aircraft fleet. The same conclusions hold for the offloaded aircraft.

#### Runway Restoration

[REDACTED] A nuclear weapon attack on an airfield will produce widespread destruction of buildings, vehicles, and above ground equipment. As noted earlier, damage to the runways can range from short-term denial resulting from scattered debris to long-term denial resulting from massive debris (ejecta), rupturing or cratering. Fallout does not damage the runway surface but can delay the start of clearing, repair, and construction activities until radiation activity levels decay enough to permit effective use of repair crews.

#### Extent of Damage, Clearing of Scattered Debris

[REDACTED] The first step in restoration is a survey to determine the extent of damage to runways and the intensity of radioactive fallout. Buildings and above ground equipment will generally not be salvageable. Clearing a runway of scattered debris may be the only action required if air bursts were employed or if the miss distances of surface bursts were great enough. How soon this can be accomplished depends on the intensity of radioactive fallout and the availability of equipment and crews. The positioning of clearing crews and equipment near the airfield will be an important time factor since movement through intense fallout at the airfield may be as great a personnel hazard as the clearing operation. Upwind locations, hardened equipment storage near the airfield, rapid personnel transit by helicopter, and shielded personnel carriers will contribute to the capability for early runway clearing.

## Method of Restoration

When runways are covered by massive debris, or are damaged by the rupture zone or by the crater, a decision must be made on the most effective method of restoration. Location of the crater and massive debris will determine whether it is best to clear and repair the existing runway, to extend the longest undamaged section, or to extend or widen the longest undamaged taxiways. In some cases the best approach to obtain a short runway for minimum weight operation may be different from the best approach to obtain a longer runway.

## Factors Affecting Repair Time

The time required for restoration will depend on the availability of equipment, construction crews, and construction material and on the delay while waiting for fallout intensities to decrease. The decision on whether to fill a crater and repair the runway or to extend the longest undamaged section depends on suitable terrain for extension and the relative availability of surfacing material compared to earth-moving machinery. More concrete or asphalt is needed for new construction, more earth-moving volume is needed to fill a crater. As will be seen below, it is generally preferable to extend the runway if possible.

This study examined the time and equipment requirements for debris removal, crater filling, runway repairs and resurfacing, runway/taxiway extensions, and new runway construction. The time delays and work restrictions imposed by fallout were included. In most cases, the time required is reduced directly as the amount of equipment available increases. Sequential use of equipment is advantageous in some cases where restoration and runway surfacing operations are in progress on other airfields near enough to permit equipment transit.

## Earth-Moving Equipment

In order to make comparisons of runway restoration times for different aircraft, the same nominal quantity of earth-moving equipment was

[REDACTED]

assumed to be available to each restoration activity. The quantity selected was the earth-moving capability equivalent to the capacity of 10 bulldozers equal to a Caterpillar D-7. Equipment capacity was taken as the normal capacity quoted by the N.C. "Caterpillar" local Seattle office.

[REDACTED] Information in the 1972 Census of Manufacturers shows that the U.S. produces about 15,000 items of earth-moving equipment yearly. Industry could readily adjust production schedules or increase production over a few years' span to make 10% to 20% of current production rates available for runway restoration stockpiles. Thus over a 10-year preparation period, ten units of equipment could be produced and stored at each of 1500 to 3000 sites with no disruption of existing industrial production or construction programs. The price of equipment equivalent to 10 large bulldozers would be about two million dollars (1979 dollars). From this price and from the U.S. industrial capability, it was concluded that equipment equivalent to 10 bulldozers was a realistic value.

#### [REDACTED] Earth-Moving Equipment Protection

[REDACTED] Tests conducted at the MISERS BLUFF high explosive field test in July 1978 (Ref. 6) demonstrated that earth-moving equipment can be protected to overpressures of several hundred psi quickly and cheaply by shallow burial. A combination of dispersal and expedient protection assures that restoration equipment will not become an attractive target so there is high confidence that equipment could be made available when needed.

#### [REDACTED] Crater Dimensions

[REDACTED] The size of a crater formed by a nuclear weapon burst at or near the earth's surface will vary with the characteristics of the soil. Since dry soil or soft rock are representative of typical airport geology, the crater dimensions given for dry soil or soft rock in reference 3 were used in this study. Table 5-5 lists the crater dimensions for the range of yields of interest to this study.

**Deleted**

A schematic of the crater depth and ejecta depth for two yields is shown in Figure 5-3. The dashed portions of the curves are estimated profile shapes since the equations given in reference 3 do not give the entire crater and ejecta profile. As noted before, at distances beyond the continuous ejecta limit the debris is primarily deposited in a number (usually 7 to 10) of rays with much less debris between the rays. The debris depths shown are average values that would occur if the material in the rays were distributed equally in all directions. This is reasonable for calculating the expected volume of debris that must be moved for runway restoration. Any selected runway, however, could have considerably more or considerably less debris than predicted using average values.

**Volume of Debris**

For runway clearing, the volume of debris to be removed was calculated using average debris depths for the geometries shown in Figure 5-3. Using data obtained from construction machinery manufacturers it was found that for our clearing geometry a typical bulldozer can move about 5 cubic yards of soil off the runway in an average 3 minute round trip. Thus, a representative average value of volume moved is 1.67 cu yd per min. This will vary with soil type and particularly with moisture content. In fact, if heavy rains should turn the ejecta to mud, bulldozers may not be able to operate efficiently until the soil dries. The time required to carry out runway repairs or clearing operations depends on the number of earth-moving machines available. In making clearing calculations it was assumed that equipment

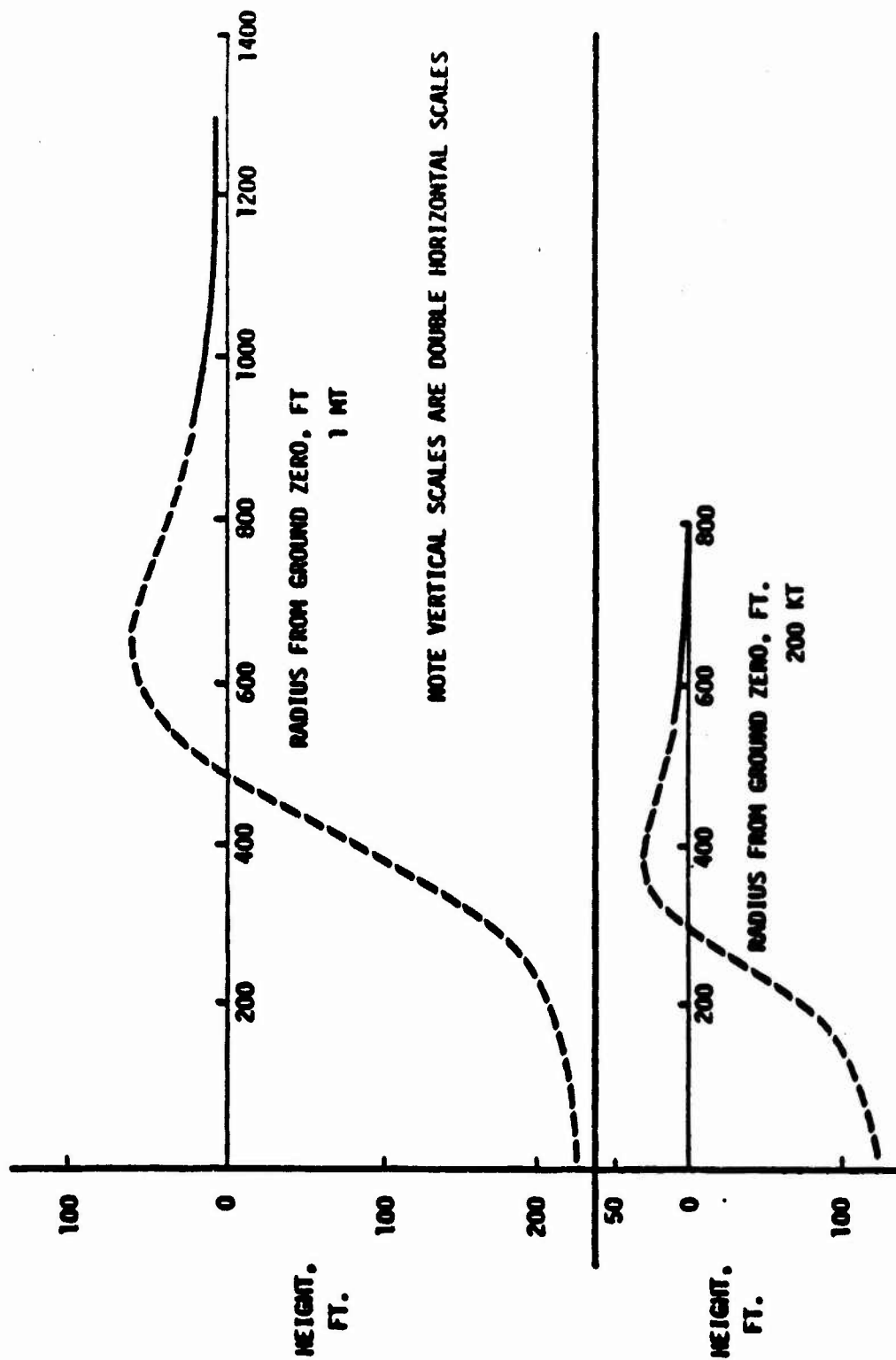


Figure 5-3. Crater and ejecta dimensions.



[REDACTED]

equivalent to 10 average size bulldozers (Caterpillar D-7) would be available.

### Repair Techniques

Consider those cases in which a runway is to be repaired. When the runway surface is ruptured, it must be leveled and resurfaced after the debris is removed. If the runway is cratered, the crater must be filled and a new runway surface prepared. However, because the crater volumes for megaton weapons are very large (it would take 127 twenty-four hour days for 10 bulldozers to completely fill a 1 MT crater) it is quicker to construct a new runway than to fill in the crater.

### Decision Criteria

As noted earlier, the decision on whether to fill a crater or to construct a new runway depends on the availability of suitable terrain for new construction and the relative availability of surfacing material (more concrete or asphalt is needed for new construction) compared to earth-moving machinery (more fill may be required to fill a crater than to level a new runway). Table 5-6 gives new runway construction times based on use of a gravel base runway with a cold asphalt/concrete surface. This type of runway is cheaper than a concrete runway, is simpler to construct, and does not require the 28-day cure time of a concrete runway. The thickness of gravel and asphaltic concrete listed allows 200 passes (takeoffs or landings) for each aircraft type.

In many cases it is simpler (terrain permitting) to clear and extend one segment of a cratered runway than to fill the crater or build an entirely new runway. Table 5-7 gives the times required to extend the U.S. bomber runways. (Comparable times are assumed for Backfire airfields.) The extension times were calculated using the minimum runway length required. For example, the minimum runway length for the fully loaded B-52 is 7400 ft while the average B-52 capable runway length is about 9800 ft. If a 1 MT weapon craters the middle of the runway, then segments of about 3900 ft length remain. One of these must be extended 3500 ft to yield a 7400 ft runway.

Table 5-6. Dimensions and construction times, new runways.

AIRCRAFT FULLY LOADED	RUNWAY DIMENSIONS		ASPHALTIC GRAVEL THICKNESS IN.	CONCRETE THICKNESS IN.	CONSTRUCTION TIME, DAYS
	LENGTH, FT	WIDTH, FT			
1. B-52	7400	170*	18	5	47
2. Retainable Bomber	4000	100	10	0	6
3. Backfire	5000	100	15	4	15
MINIMUM LOAD					
1. B-52	4400	170	18	5	28
2. Retainable Bomber	2500	100	10	0	4
* Outriggers assumed to be needed.					

Table 5-7. Times required to extend cratered U.S. runways.

AIRCRAFT	RUNWAY EXTENSION TIME, DAYS
FULLY LOADED:	
1. B-52	22
2. Retainable Bomber	4
MINIMUM LOAD	
1. B-52	7
2. Retainable Bomber	3

[REDACTED]

The results of an analysis of probabilities of interdiction of bomber runways is shown in Table 5-8. Two bomber configurations were considered, i.e., the B-52 with a minimum required runway length of 7400 ft and a conceptual retainable bomber requiring 4000 ft runways. The interdiction criterion was the length of undamaged runway remaining. Cases 1, 2, and 3 deal with a fully loaded B-52 indicating that a single weapon (Case 1) produces 85% probability that no segment of 7400 ft or longer will survive. Case 2 shows a 22% probability that no segment of 4400 ft will survive a single weapon attack. That interdiction probability is significantly increased if two weapons are used (Case 3). The fourth case considers shorter runways capable of accommodating an off-loaded bomber. A similar set of data was developed for the conceptual retainable bomber. A majority of the attacked runways can be best reclaimed by extending one of the surviving runway segments. The required extension can range from a trivial addition for a runway hit near one end, to almost the full length of a new runway for the case in which a long runway is attacked with multiple RV's, two of which are targeted rather near the ends. The greatest time depicted in Figure 5-4 is that required to build a totally new runway. Consideration was given to most rapid reconstitution of useable runways and best use of equipment and personnel. The possible delay in start of construction resulting from the presence of radioactive fallout is not included in the data of Figure 5-4. This could delay start of construction by as much as 6 to 16 days depending on miss distance and wind direction. It appears from the analyses that about 20% of the runways will be restorable by simply clearing the debris from the largest remaining segment. On the otherhand, about 10% will be damaged in such a way that new construction is the only plausible course. It is shown clearly that the lesser requirements of a retainable bomber make it possible to have runways repaired or replaced in less than ten days.

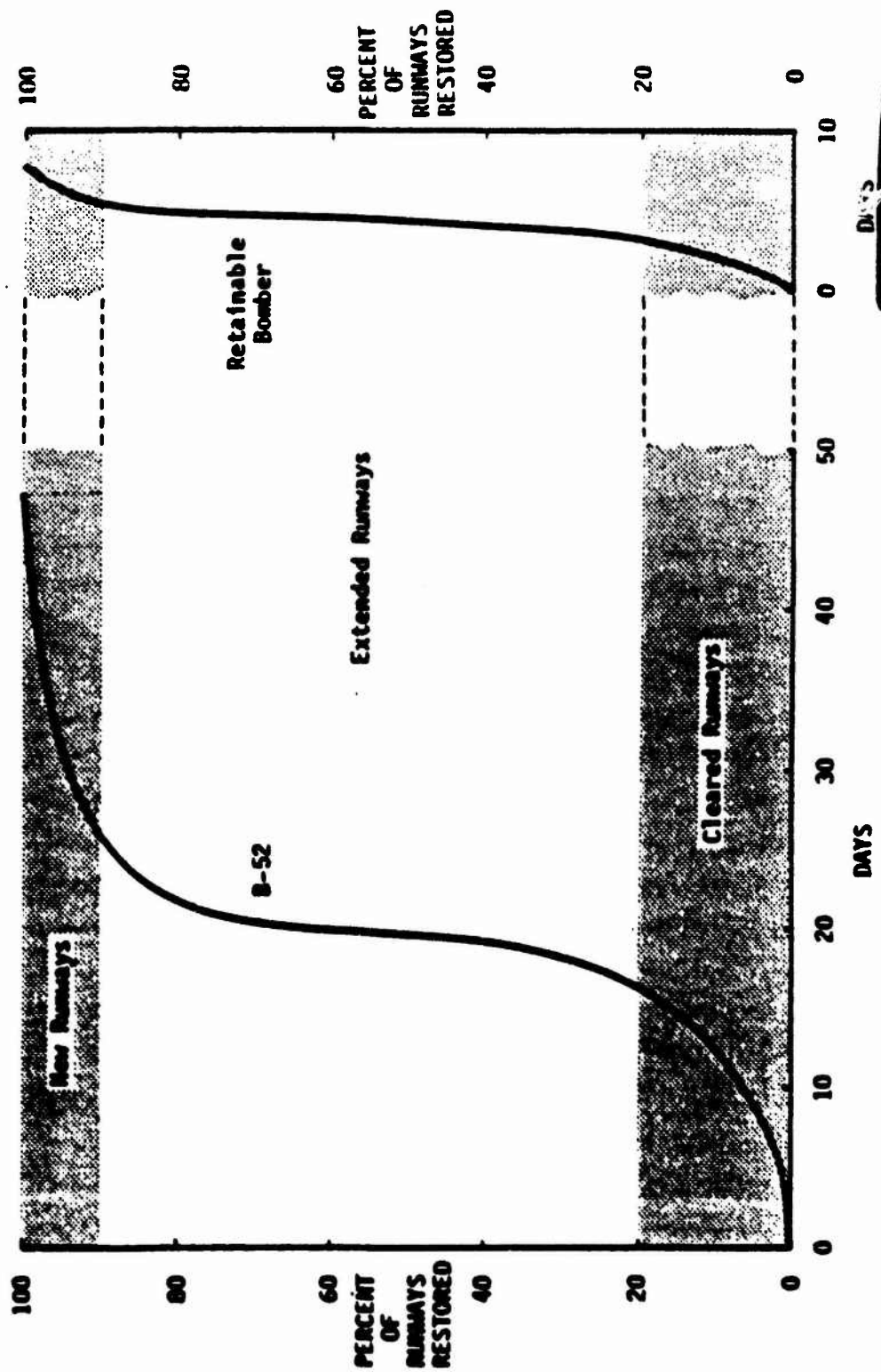


Figure 5-4. Runway repair and replacement times.

Table 5-8. Interdiction probabilities.

AIRCRAFT	CASE	NUMBER OF WEAPONS USED	AVERAGE RUNWAY LENGTH, FT	NO SURVIVING RUNWAY SEGMENT GREATER THAN	P <sub>I</sub>
B-52	1	1	9800	7400ft	0.85
	2	1	9800	4400	0.22
	3	2	9800	4400	0.66
	4	1	5590	4400	0.83
RETAINABLE BOMBER	5	1	5000	4000	0.83
	6	1	5000	2500	0.50
	7	2	5000	2500	0.69
	8	1	3300	2500	0.86

#### 5-2.1.5 Storage of Weapons and Other Critical Assets

The concept of conducting a protracted war following a nuclear attack on military installations produces, in addition to requirements for weapon delivery systems, the need for assured availability of weapons and other critical components. In this section attention will be focused on weapon protection. However, the same techniques will protect other critical assets. Nuclear devices, for example, must be available for use by enduring strategic strike forces. The discussion of the protracted war environment (Section 3-3) included the assumption that all nuclear weapon storage and manufacturing sites in the U.S. would be attacked and probably destroyed. Several ideas have been pursued at Boeing during the past years on how to assure enduring availability of such items as nuclear warheads and delivery systems. Two specific concepts are described here.

#### Shallow Burial/Dispersal

The idea of protecting individual warheads or ALCM's for use during the protracted war has been developed and tested in several high explosive tests (References 6 through 9) in which Boeing participated under DNA auspices. It was demonstrated that equipment could be protected against blast/ground shock damage by surrounding it with crushable material and burying it in the soil.

[REDACTED]

[REDACTED] For example, Figure 5-5 shows measures employed at the DICE THROW event to protect a minibike emplaced at the 600 psi (4.1 MPa) overpressure range. Figure 5-6 shows the minibike being recovered with only minor sheet metal damage. In fact, it was immediately started up and driven away.

[REDACTED] Figures 5-7 and 5-8 show a grinder being emplaced and recovered in the FOAM HEST 2 (Reference 9) event which simulated the blast and impulse environments at the 900 psi (6.2 MPa) range from a 100 kt surface burst. The grinder received only superficial damage.

[REDACTED] In almost all of these tests aluminum chips from Boeing machining operations were used as the crushable material because they were readily available. Foams with well-defined properties would be the preferable material for weapon protection. Figure 5-9 shows the general scheme for protecting weapons with foam and soil. The thickness of foam and depth of burial depend on the expected soil motion and thus on weapon yield. The dimensions shown are expected to protect a weapon or other item of diameter D against the environments produced at the 1000 psi (6.9 MPa) range from a weapon with a yield of about 1 Mt. (Additional field tests would be needed to simulate this intense environment.)

[REDACTED] Reference 10 examines several possible mechanisms which could supply protection to shock-mounted, buried equipment. These are dynamic soil arching which would carry stresses around the foam and weapon, "snowplowing" which is an energy absorbing crushing action of the soil, and reflection of most of the blast wave energy at the soil-foam interface due to the impedance mismatch. It is possible that all these mechanisms come into play.

[REDACTED]

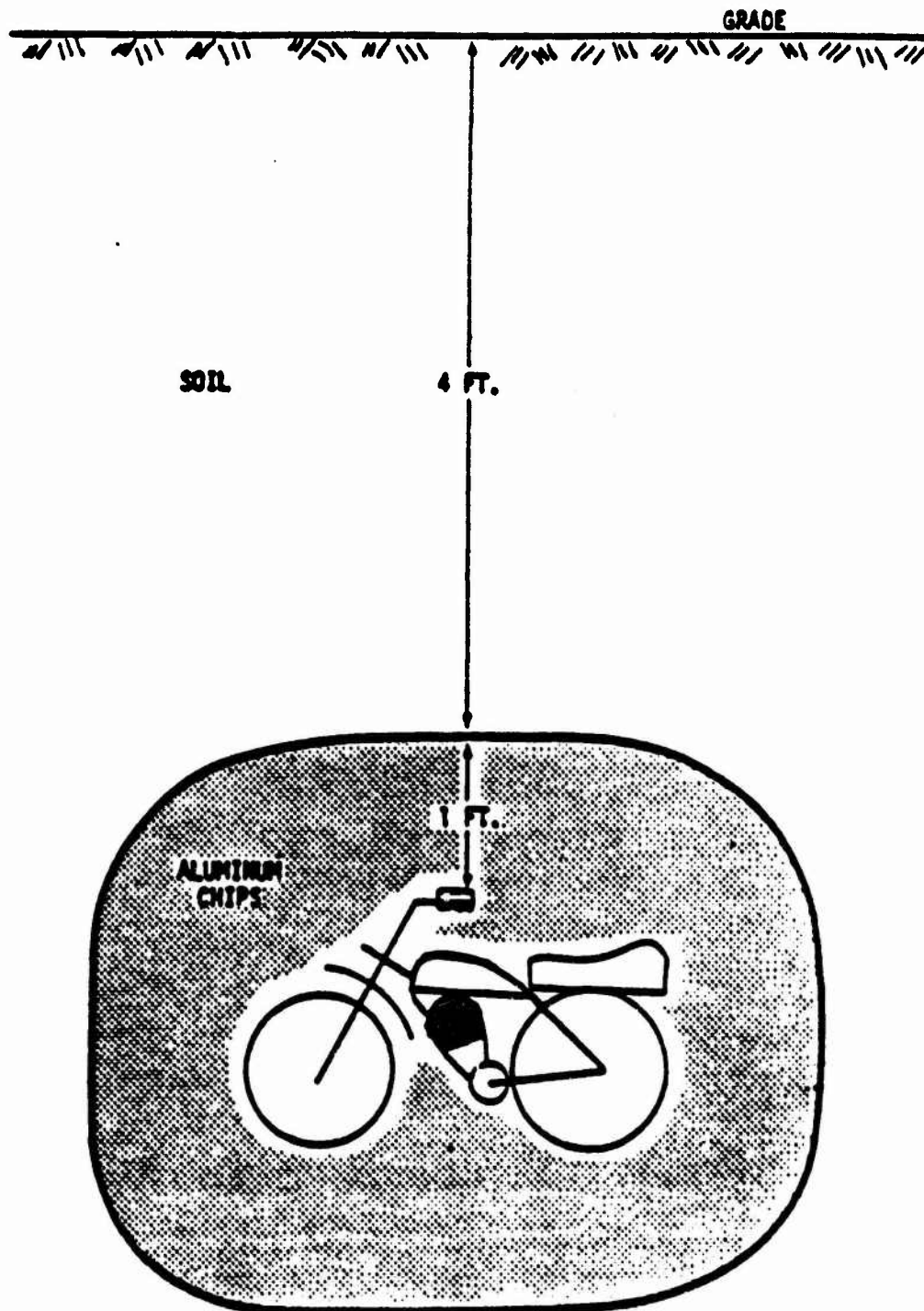


Figure 5-5. Minibike protection measures of Event DICE THROW.



Figure 5-6 Post-test Recovery of Minibike





Figure 5-7 [redacted] Grinder Protective Measures On FOAM HEST 2



Figure 5-8 Post-test Recovery of Grinder

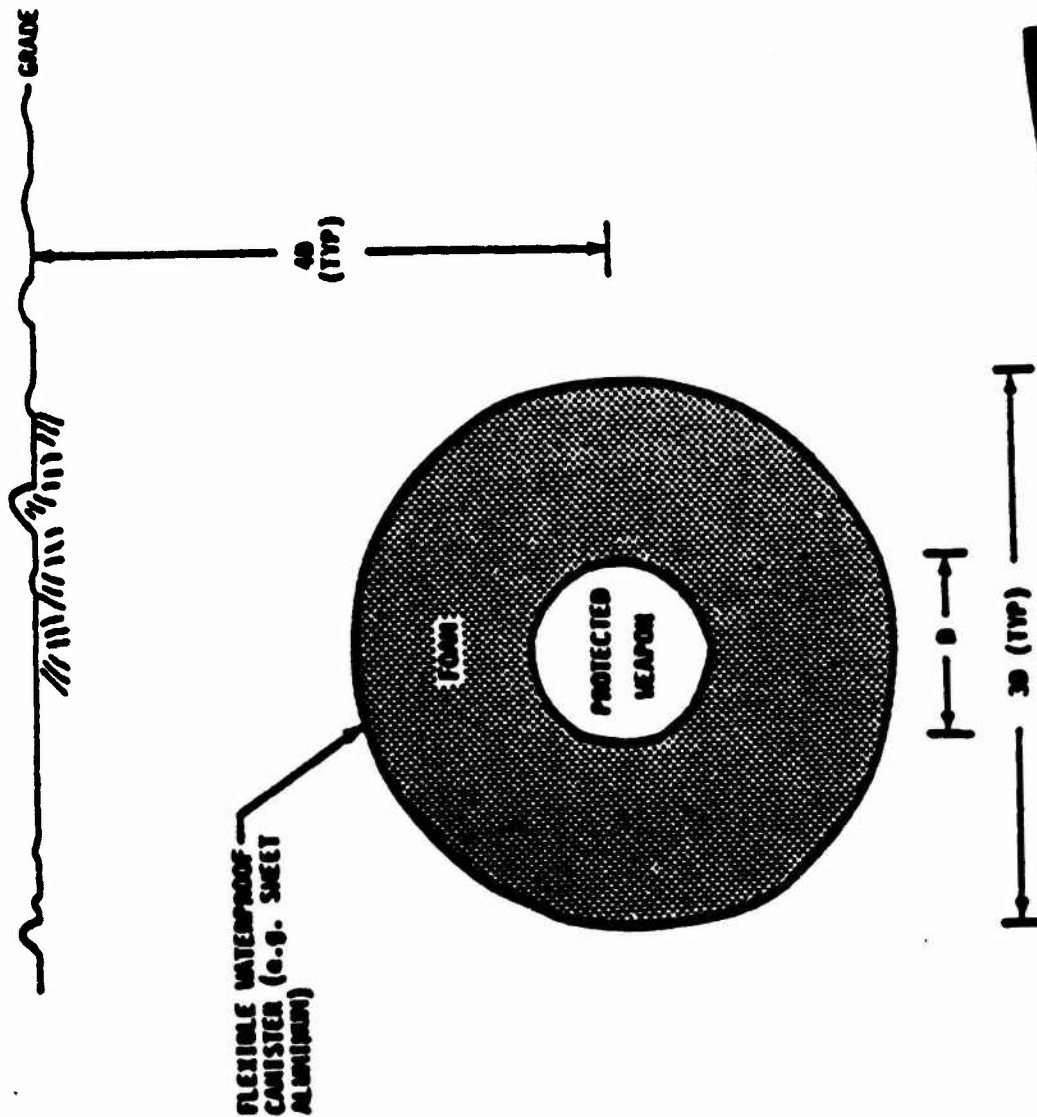


Figure 5-9. Dispersed burial for protection.

[REDACTED]

[REDACTED] A waterproof flexible canister made of sheet aluminum or fiberglass would be designed for each weapon type and the weapon foamed into the canister, with sensors emplaced to warn of any intrusion after the weapon is buried. (The concept illustrated in Figure 5-9 shows a section normal to the warhead or weapon axis.) The canister would be placed in a trench prepared by a bulldozer, the intrusion sensor cabling connected, and the canister buried.

[REDACTED] Required Hardness-Dispersal Analysis

[REDACTED] It is of interest to determine what combinations of hardness and dispersal would be adequate for survivability/retainability. The following represents one approach to this problem. It is assumed that ALCM weapons are to be stored in hardened dispersed storage and that these weapons will be adequately survivable if an attack on them would expend more EW (see Appendix B) than it destroys.

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[REDACTED] Warhead yields, of course, decrease as the numbers of RV's per booster increase. (The problem of whether adequate time was available to release the larger numbers of RV's before reentry was not addressed.)

[REDACTED]

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[REDACTED] The two largest existing military installations are Luke and Nellis Air Force Bases with areas of 4000 to 5000 Mi<sup>2</sup> each. Thus, if large numbers of items are to be protected, the higher hardness levels are preferable. The earth-moving costs (a few hundred dollars per item) are a very trivial part of the total hardening costs (which include a special foam-lined canister, instrumentation, special fencing and 24-hour protection). Thus, there is little point in considering less than optimum burial depth (Figure 5-9) unless ground water or local geology do not permit such burial. If such geology must

[REDACTED]

be used, earth should be mounded over the protected item to the depth 4D shown in Figure 5-9.

[REDACTED] It is anticipated that the conditions of Figure 5-9 with the foam properties carefully chosen to best attenuate ground shock could supply protection against megaton yield weapons at the 1,000 psi range or above. A somewhat larger HEST test than FOAM HEST 2 could supply the necessary blast, impulse and ground shock environments to determine whether 1,000 psi hardness is achievable. If it is, Figure 5-11 indicates that the total storage area requirement would drop about 25% from the 500 psi area.

[REDACTED] A major problem which must be addressed is assuring warhead security against theft in peacetime. As noted earlier, each container should be instrumented to detect tampering. Security forces would have to be on duty at all times. The standard triple fence for nuclear security would be used to surround the storage area.

[REDACTED] As noted in this discussion of shallow burial, there are major problems which must be addressed. These are: assuring warhead security, finding adequate space and the location of the weapons near their potential users. This is particularly important for generation of forces at increased DEFCON levels.

#### [REDACTED] Shallow Burial/Tunnels

[REDACTED] A concept which could utilize the hardening benefits of shallow burial while providing for reasonable security costs and availability will now be discussed. Fundamentally this concept would utilize shallow tunnels (10 to 15 meters underground) which are now becoming economically feasible with tunneling methods being developed. Such tunnels could be constructed in many areas of military bases (see Figure 5-12). While the several entrance points could be known by an opponent through overhead observation, the exact course and layout of the tunnels would not. Branching from these tunnels, storage sites could be built which would consist of slightly downward inclined concrete (or steel) cylinders sized to accommodate the weapon being stored. The weapon, contained in a waterproof canister as previously described, would

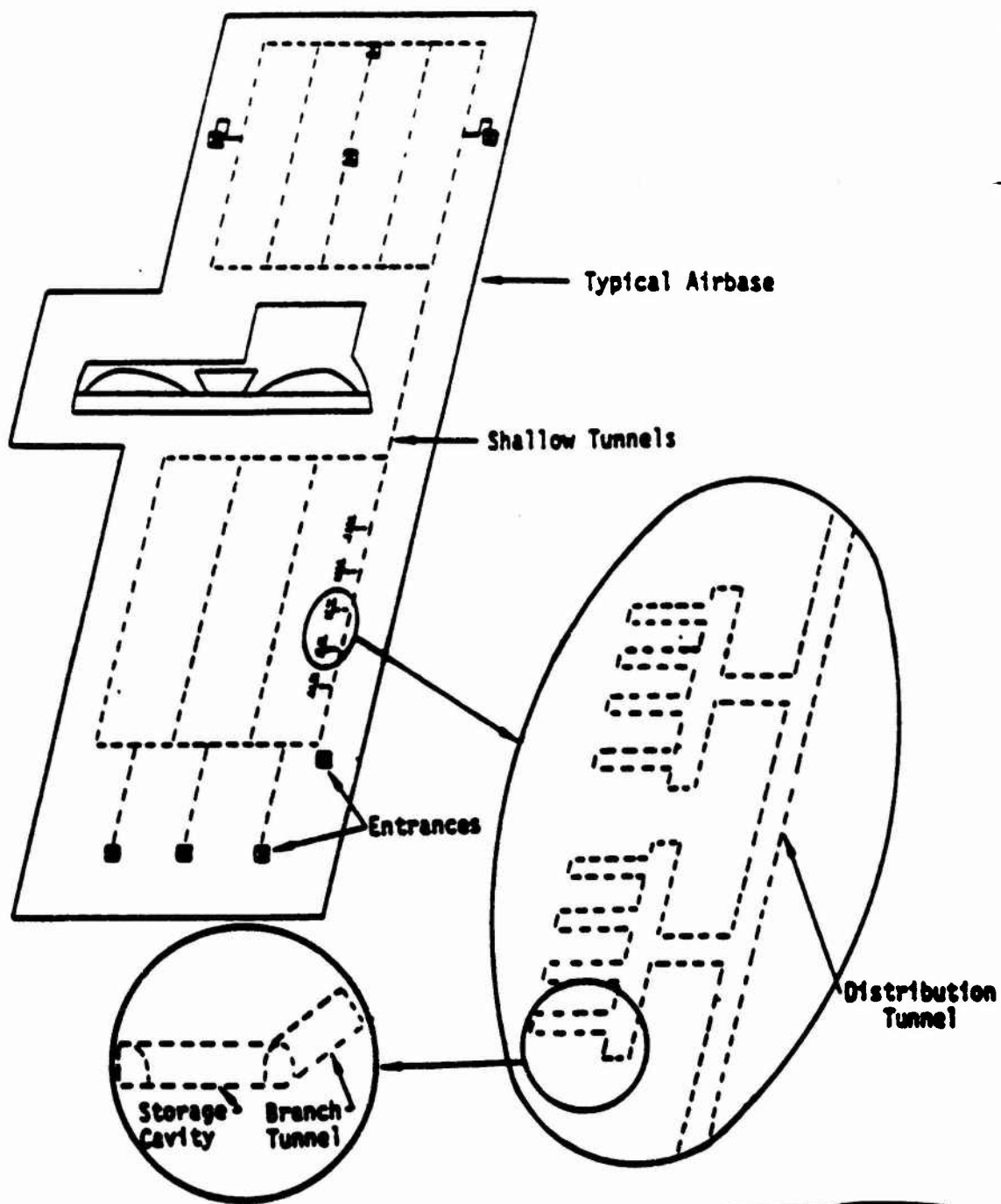


Figure 5-12. Shallow tunnel concept for weapon and parts storage.

[REDACTED]

be surrounded with additional foam and buried in dry sand in these cylinders. A suitable door would be provided. It would serve both as a blast and security shield. As before, the weapon would be instrumented so that nuclear monitoring could ensure the presence of the weapon, and other sensors could warn of tampering or intrusion.

[REDACTED] Such a complex could be used not only to store nuclear weapons, but to store other high value parts and material. However, the degree of protection provided other items (and the associated costs) need not be as elaborate as for weapons. The tunnels could also serve as fallout shelters and provide some degree of blast protection for base personnel.

[REDACTED] What such a complex would do is introduce, in addition to hardening, some degree of enforced miss distance on the attacker's weapons. He could, of course, overcome this by a multiple weapon laydown on the entire base. This then makes the base another element of a multiple protective shelter scheme whose purpose is to exhaust the attacker's weapon inventory. If only one or two bases were so equipped, the attacker could easily defeat it. But if this were a scheme adopted at all bases and one which was gradually and continuously expanded, it would soon become too weapon expensive to defeat by direct attack. There is also synergism with other systems (e.g., MX, dispersable, retainable bombers) that further reduces the degree of hardening or area of dispersal which must be achieved in order to convince an opponent that an attack is futile. Such storages due to their ability to be monitored at entry points and patrolled would probably not increase security forces above those now used at existing storage sites.

#### [REDACTED] Deep Underground Storage

[REDACTED] An alternative for weapon storage is the use of deep underground spaces. In this case, because of the cost of creating such spaces, it would most likely occur as an adjunct to a deep based facility for which this type of protection is warranted. Deep basing concepts are discussed in the following section (5-2.2), and use of such levels of protection becomes of interest for high value items, or, on the other hand, because space is available and



[REDACTED]

security monitoring is provided by personnel assigned to the underground base.

## 5-2.2 [REDACTED] Retainable ICBM Concepts

[REDACTED] Several approaches to ICBM basing have been considered (1) deep basing, (2) multiple protective structures (MPS), and (3) combinations of hardening and dispersal with mobility. Eventual determination of the most suitable approach will have to resolve several competing considerations with respect to ICBM payload size and composition. During a protracted war, intercontinental attacks on military targets of opportunity will call for just one or two warheads, i.e., such targets would not be appropriate for large MIRV'ed ICBM's. On the other hand the larger missiles would be suitable for attacking (or threatening to attack) urban-industrial targets and in general would be a less costly way of providing a given amount of firepower. In addition, proposed SALT II constraints on land-based ICMB's inhibit introduction of any substantial number of small ICBM's. If such constraints were sufficiently modified (e.g. limits based on RV's instead of SNDV's), then small ICBM's become viable candidates.

### 5-2.2.1 [REDACTED] Deep Basing Concepts

[REDACTED] As noted earlier, the requirement for certain military activities not only to survive the initial nuclear attack, but also to endure to carry out military functions during the protracted war, creates the need for special basing concepts. One of the concepts for providing protection and endurance for high-value activities is deep burial of autonomous systems and/or critical resources. In the past, two types of high-value activities have been considered for deep underground basing in order to provide them with desired survivability and endurance. These are bases for secure (strategic) reserve forces and major command centers. Over the past 30 years the U.S. defense establishment has made several starts at development of concepts for very hard installations for ICBM bases and for a National Command Center. The chart in Figure 5-13 shows chronologically the occurrence of various deep basing concepts. The current deep missile base concept was developed in response to the emerging requirement for a future secure reserve force (FSRF) as described in

[REDACTED]

Reference 11. The referenced report addresses the role of such a force in some detail and expresses the prime motivation for it to be the need for endurance during protracted war, flexibility to respond to complexities of threats, and a high degree of survivability.

[REDACTED] When considering deep-based facilities for strategic reserve forces, it has been necessary to postulate missions for the force since no requirements have been published yet. It appears reasonable to remove such a reserve force deliberately from functions that require a quick response. A deep-based force needs to be flexible in terms of targeting and missions. It should include the capability to launch replacement space vehicles, as well as to attack strategic targets, fixed and moving. The possible requirement to attack moving targets seems to contradict the earlier assertion that it should not be a quick reaction force. However, they are not the same issues. Providing the capability to attack moving targets, e.g., projection forces, requires the ability to update target information at time of launch and possibly even during flight.

[REDACTED] All but one of the previously considered concepts (see Figure 5-13) for deep-based missiles were manned facilities. The exception is the "Quick Egress" concept which proposed deployment of ICBM's in deep shafts filled with saturated sand. There is, of course, the option in deep-based systems to omit the crew, creating in essence a dormant storage facility for ICBM's and other strategic weapons, or for command posts which would be entered during the protracted war when the decision is made to use the weapons or to activate the command post. Only very preliminary consideration has been given to such an option.

[REDACTED] Siting

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Figure 5-15 Mesa Based FSRF

Table 5-9. Weapons effects/damage mechanisms.

● ATTACK:

- NUCLEAR SURFACE BURSTS WITH SIMULTANEOUS DETONATIONS.
- NON-NUCLEAR ATTACKS NOT YET CONSIDERED.

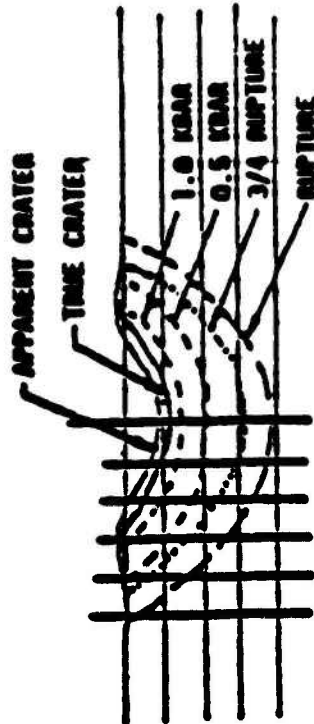
● EFFECTS:

- PEAK DYNAMIC STRESS:  $\sigma_{max} = (K) \rho_0 c u$
- RUPTURE:  $P_R = (1 + \phi) P_T$  (TIME RADII)  
 $P_R = (1 + \phi') E_T$  (TIME DEPTH)

(ARMADIAN ASSOCIATES' INTERPRETATIONS OF: AFML-TR-74-81, BMA 3245F, SAND 74-0252).

● DAMAGE:

- PEAK DYNAMIC STRESS: UNLINED TUNNEL IN DRY SOFT ROCK CAPABLE OF .5 KBAR (MURPHY-CASES INTERPRETATION OF TEST DATA).
- RUPTURE: MODIFY VALUES OF  $\phi$  AND  $\phi'$  ABOVE, BY 0.75 (DOERING ASSUMPTION).



[REDACTED]

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[REDACTED] A Deep Basing Concept

[REDACTED] The current version of the deep missile base concept investigated by Boeing for DNA under contracts DNA 001-C-0225, 78-C-0315, and 79-C-0297 is shown in Figure 5-15. It was in part derived from the RDA and AFWL papers on mesa basing. The mesa concepts assumed that mesas could be found with sufficient vertical relief to facilitate horizontal exits from a tunnel system in the mesa. The first Boeing effort in this deep basing study series was to find a solution to the likelihood that all preconstructed exits from a deep-based system could be destroyed by the attacker. The proposed solution was to deploy tunneling equipment and miners with the missiles. This was shown to be feasible.

[REDACTED] Subsequent studies addressed the effectiveness of deep-based missile systems for purposes of power projection during protracted war, and also the definition of critical subsystems. The effectiveness analyses used an assumed threat against the deep base, i.e., the entire LRA Backfire fleet, and as mission requirement the survival of a specified number of MX type ICBM's. This led to a concept as illustrated in Figure 5-15, where missiles on transporter-launchers are deployed in an extensive tunnel system. Included in the system are a number of tunnel boring machines, crews, and power plants capable of supporting a one-year life support period and power for completing partially predug exit tunnels or construct new exits as may be required. Hydrocarbon fuel cells were proposed for this system.

[REDACTED] No significant technical problems were identified in these system studies and the costs were found to be comparable to those of other weapon systems of similar complexity. In the process of ascertaining the feasibility of constructing such extensive tunnel systems, Boeing planned and conducted for DNA a Tunneling Technology Seminar on 31 October 1978 (see Reference 14).

[REDACTED]

Invited participants at this seminar were about 30 selected representatives of the tunneling community, e.g., tunnel builders, tunnel owners, tunnel designers, and manufacturers of tunneling equipment. The other attendants were military planners of strategic systems. The tunneling community representatives affirmed the assessment that such tunnel systems as proposed by Boeing for a deep missile base are feasible and can be constructed in the 5-year construction period. They also concurred in the digout concept.

[REDACTED] The Boeing study of critical subsystems also addressed the fuel cell power plant concept in sufficient detail to ascertain its suitability. In a subtask United Technology Corporation developed the supporting data for hydrocarbon fuel cell operation, efficiency, and cost. That type of power plant is similar to one currently being assembled on the east side of lower Manhattan. That plant is to be tested later this year and begin operation in 1981. Its design capacity is 4.8 megawatt. It will be operated by Consolidated Edison as part of its power supply system. The choice of that type of power plant for a deep-based, long-endurance system was guided by its thermal efficiency and wide operating range. One of the prime concerns regarding power systems is to minimize production of waste heat which must be absorbed within the closed system during the endurance period.

[REDACTED] In both the command post and missile base investigations, extensive cost analyses were made for the missile base investigation as well as for a recent Command Center concept. In the command center project it occurred that excavation (i.e., tunnels and shafts) costs approached 80% of the estimated project cost. This is primarily attributed to long tunnels for ELF antenna elements. While for the missile base (see cost breakdown in Figure 5-16) the excavation cost makes up 37% of the cost of system acquisition. In this case the cost of equipment, especially the missiles, exceeds the excavation costs.

[REDACTED] In summary, it is possible on the basis of the various investigations conducted so far, to conclude that deep-based facilities can provide the survivability and endurance sought for strategic systems required for conduct of prolonged nuclear wars, and that they can do so on a cost effective basis.

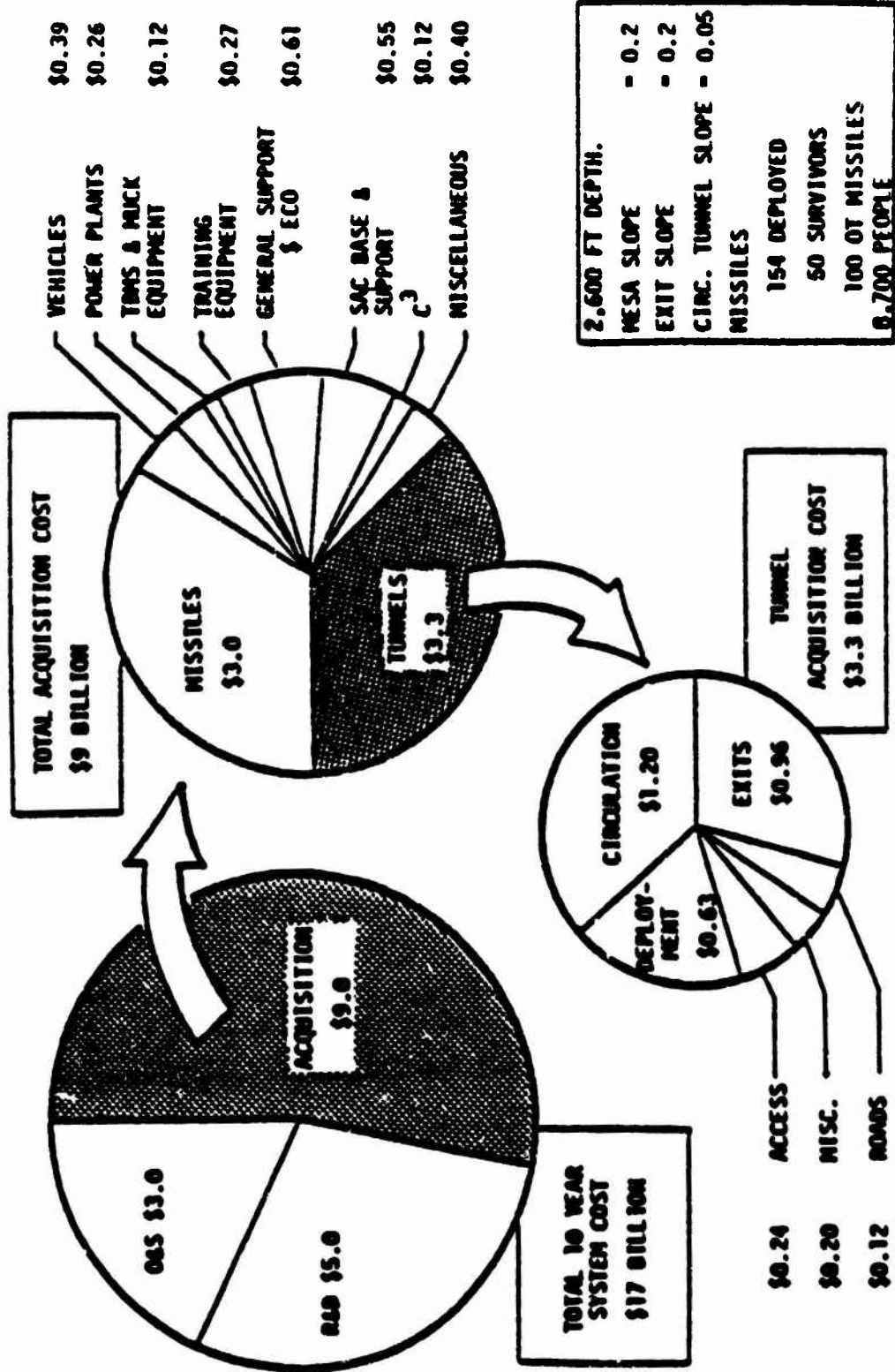


Figure 5-16. Cost breakdown for baseline system.

#### 5-2.2.2 [REDACTED] Multiple Protective Structure (MPS) Concepts

[REDACTED] This approach uses more than one shelter per missile with shelters hardened just to the level preventing destruction of more than one per attacking warhead. The MPS concept with its mechanisms for preservation of location uncertainty, PLU, is well known from MX-MPS literature and will not be described in detail here.

[REDACTED] The criterion for retainability is very difficult to determine for these systems because they are potentially both targets and responding weapons in the counterforce nuclear exchange stage of conflict (see Section 3-3). Survivability levels which are adequate for the protracted warfare stages are not necessarily good enough to prevent attack during the counterforce exchange because these ICBM's are weapons which can respond counterforce if left undestroyed.

[REDACTED] To remain in usable condition during and after a nuclear exchange, the missiles must be provided with a source of electrical power independent of commercial power systems. One approach is to provide batteries which for some period of time will maintain missiles in a state of full readiness and then transition into a dormancy mode requiring a much lower level of power. The time required for restoration into the ready condition would probably be substantial indicating an inability to deal with time-urgent targets.

[REDACTED] If full readiness for much longer periods of time is required, some means of power generation from fossil or synthetic fuel can be installed. Replenishment of fuel would require fuel storage and transportation means in a prearranged survival configuration or could be accomplished by a multistage process in which this capability is generated from more rudimentary beginnings.

[REDACTED] Preservation of location uncertainty will still be required in the post-exchange protracted war period. The elaborate measures and procedures involved in PLU during the prewar period will still be necessary. It will not be possible to know that absolutely all potentially compromising surveillance has been denied. Relocation of missiles with corresponding movement of



[REDACTED]

decoy/simulation devices will be required. This means that all PLU equipment must reside in an adequately survivable configuration, either as part of the operational system or as reserve equipment.

[REDACTED] Immediately after a counterforce nuclear exchange and perhaps periodically thereafter, major radioactive fallout problems may be encountered. Adequate protection measures will be required for operational personnel including provision of fallout shelters, protective clothing, limitation of exposure time, and perhaps construction of shielded compartments in the transporters.

[REDACTED] The road or track network provided for the PLU movements may be seriously disrupted during the nuclear exchange. Restoration measures analogous to those discussed in the "Runway Restoration" section can be implemented.

#### 5-2.2.3 [REDACTED] Mobile Booster With Hardened and Dispersed Payloads

[REDACTED] The concepts considered here are those in which the missiles, with payload removed, are carried in vans resembling commercial vehicles, moving on the public network of primary and secondary roads. The payloads for security reasons are kept in moderately hard dispersed storage until needed, at which time the payloads are transported, perhaps by truck or helicopter, to rendezvous points where the two portions of the missile can be joined. Because of highway weight restrictions and the need for the vans to resemble common commercial vehicles, the missiles must be relatively small with payloads of at best perhaps three Mark 12A warheads.

[REDACTED] Determination of the required level of survivability during the protracted warfare period is complicated by the fact that these missiles may be both responding weapons and targets\* in a counterforce exchange. If adequate survivability cannot be achieved with one storage site per payload (as is likely at least for the higher value payloads), then a multiple

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\*Presumably the storage sites would be targeted rather than the mobile units, although the road network and presurveyed launch positions configuration must be extensive enough to discourage direct attack.

[REDACTED]

protective structure arrangement could be adopted. This would increase system complexity and cost, although substantially less so than for the complete missile MPS concepts discussed in Section 5-2.1.1. The storage structures and the transporter vehicles would be smaller and simpler in construction. The decoy/simulation arrangements would be easier.

[REDACTED] Under wartime conditions there may be periods during which road travel is undesirable for the missile vans. The road networks may not be fully usable and greatly reduced civilian/commercial traffic may not adequately obscure van movements. Means of concealment should be available or provided at or near launch positions permitting the vans to stay off the highways.

[REDACTED] Immediately after a counterforce nuclear exchange, and perhaps periodically thereafter, major radioactive fallout problems may be encountered. Fallout shelters will be needed for both the personnel associated with the stored payloads and those associated with the mobile missile vans. As indicated earlier, provision should be made permitting the mobile missile vans to remain in prepared off-highway positions; correspondingly the personnel can remain in prepared shelters as appropriate.

[REDACTED] If an MPS approach has been incorporated for the stored payloads, then provisions may be necessary to permit crews to continue PLU procedures in fallout environments. A combination of protective clothing, exposure time limitation, and shielded compartments in the transporters and other vehicles will probably suffice.

[REDACTED] To ensure necessary power during the protracted war period, battery or fuel conversion means can be provided for the payload storage units just as discussed in connection with MPS systems of Section 5-2.2.1. For the other elements of the system requiring fuel, e.g., mobile missile vans, transporters, etc., an adequately survivable fuel storage and transportation arrangement must be installed or a foundation laid for some multistage process to generate the necessary fueling capabilities.

[REDACTED] In addition to retaining the capability to conduct strategic strikes during the protracted war, the most important military mission will be to defend the U.S. homeland. This means both from invasion of its territories and those of its North American allies, and the prevention of aircraft and missile attacks. Only when the capability for both sets of missions, i.e., strategic strikes and defense of homeland prevails, will the U.S. be in position to resolve the postulated conflict in its favor.

[REDACTED] As was the case in the assessment of current U.S. strategic strike capability after a nuclear attack on its military installations, similar conclusions are drawn about the ability to defend the homeland, i.e., it will be severely impaired. Several of the major functions are identified here as worthy of further investigation and concept or capability development. The issues considered to need particular attention pertain to surveillance and attack warning, as well as the ability to prevent air attacks. The major effort needed for prevention of invasion of U.S. territory is taken to be the expeditious restoration of attacked military bases, which is aided by the proposed provision of protective measures.

#### 5-3.1 [REDACTED] Air Defense (Future Work Outlined)

[REDACTED] In the earlier discussion of bomber survivability (Section 5-2.1) it was pointed out that the Soviet Union appears to have the capability to retain a significant portion of its bomber capability. The U.S. must be prepared to protect itself against attacks by those bombers during the protracted war. Those bombers are expected to attack surviving or reconstituted strategic forces and C<sup>3</sup>I components, as well as any U.S. efforts to support its allies. Two major aspects of air defense need to be addressed, i.e., the ability to detect such attacks and to intercept them. This study effort was not able to address them in detail, however, an outline of what needs to be accomplished is presented.

[REDACTED]

[REDACTED] For the attack detection function a new capability will be needed which can detect bombers in flight. A HALO\* type sensor could accomplish this. It would hand its early detection of an approaching bomber off to a local air traffic monitor, e.g. AWACS which in turn can vector interceptors. This assumes that any ground based radars like DEW and the Cobras have been destroyed in the initial attack.

[REDACTED] The existing capability for intercepting approaching bombers lies with the ANG fighter/interceptor squadrons of which considerable capability is expected to survive. They will require maintenance support and supplies, e.g. POL, parts and ammunitions. But primarily they will need the warning and guidance capability described above.

[REDACTED] In order to assess how the air defense mission can be accomplished following the initial attack the above mentioned topics need to be addressed in some detail.

#### 5-3.2 [REDACTED] Military Base Protective Measures

[REDACTED] The homeland defense mission requires a rapid restoration of military capability after attack. One of the most effective methods for achieving that goal is to minimize the losses sustained during the nuclear exchange. Under the postulated scenario of the initial phase of the war, all major U.S. military installations will be attacked and suffer extensive destruction and casualties. This is primarily because U.S. military bases are concentrated, soft targets vulnerable to air bursts of nuclear weapons. In the process of assessing the impact of the initial attack, the idea of some rather simple protective measures arose and is pursued here in some detail.

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\* The current assessment is that HALO type sensors require a payload capability which current ICBM boosters cannot provide.

[REDACTED]

[REDACTED] Even though relatively low yield SLBM warheads were postulated to be employed against most U.S. targets it was shown in Section 3-3 that casualties would be enormous and that U.S. war fighting capability would be severely impaired. In this section cost effective means will be presented which would enhance survival of a significant fraction of mission critical personnel and equipment. One hundred percent protection of military elements or protection of dependents or civilian employees on the base are not envisioned at this stage of the study.

[REDACTED] The nuclear effects of most concern are:

1. Visible light flash which can cause blindness or eye damage,
2. Thermal pulse and the fires resulting from it,
3. Blast overpressure and accompanying winds,
4. Prompt radiation (neutrons and gammas produced within about a minute of burst time), and
5. Fallout radiation.

#### [REDACTED] Blast Shelter Details

[REDACTED] The shelters to be discussed in detail below are shallow buried structures with soil providing most of the nuclear effects protection. They are inherently immune to flash and thermal pulse, although sites should be chosen away from large quantities of combustible materials. In high explosive tests simulating nuclear weapons these shelters demonstrated considerable hardness against blast effects. Since soil is a rather good radiation shield these shelters provide considerable protection against nuclear radiation.

[REDACTED] Shelter requirements vary from one military installation to another. As noted in Section 3-3.1, Army forts tend to be much larger than Navy or Air Force installations. Also, any base with stored nuclear weapons is attacked with ICBM as well as SLBM RV's in the present scenario. Some bases will be subjected to fallout from surface burst attacks on other upwind targets. After discussing the shelters in more detail, requirements for different basing conditions will be addressed.

[REDACTED]

First consider casualty ranges for troops not in shelters. Figure 5-17 taken from Reference 15 gives casualty ranges for yields of interest. Note that the dominant effects are thermal pulse and blast. As the degree of warning and protection improves to the point of troops lying prone with thermal protection the casualty ranges drop to 7,500 to 20,000 feet depending on weapon yield. In targeting military installations, numbers and yields were chosen from among the available weapons to destroy most of the equipment and buildings at the installation (see Figures 3-6 through 3-8). The resulting nuclear environments would be sufficient to produce casualties anywhere on a Navy or Air Force installation or in the built-up area of an Army base. If a large fraction of unsheltered personnel is to be saved then dispersal away from Navy/Air Force installations or from the built-up area of Army bases is necessary.

[REDACTED]

Now consider the sheltered case. Two types of shelter were considered. An "expedient shelter" concept (specifically the pole-covered trench shelter) is discussed in Ref. 16. These shelters could be installed easily and at low cost. They could be used to shelter both personnel and equipment. The log shelter design from Ref. 16 has been redesigned to employ standard building materials (plywood, two by fours, tar paper) as shown in Figure 5-18. The soil depth of 36 in. allows this shelter to survive 15 psi blast overpressure while providing radiation shielding. (Two entrances are desirable to allow quick occupation of any shelter and to provide an alternate exit route in a post attack environment.) The steel shelter shown in Figure 5-19 is the same as that reported in Ref. 16 except that a second surface entrance has been included instead of the basement entrance used in the field test. The soil depth of this shelter provides the inhabitants with protection from prompt and fallout radiation.

[REDACTED]

A few other comments regarding these shelters are appropriate. A fallout example below illustrates that with proper preplanning, stay times in these shelters could be kept down to about a day. Food and water should be prestored in each shelter for a few days occupancy. Adequate ventilation can be provided by a Kearny air pump described in Ref. 17, or by other high volume hand or foot operated pumps. Battery powered lights are needed. Human waste can be dumped outside the shelter a few hours after attack without a large

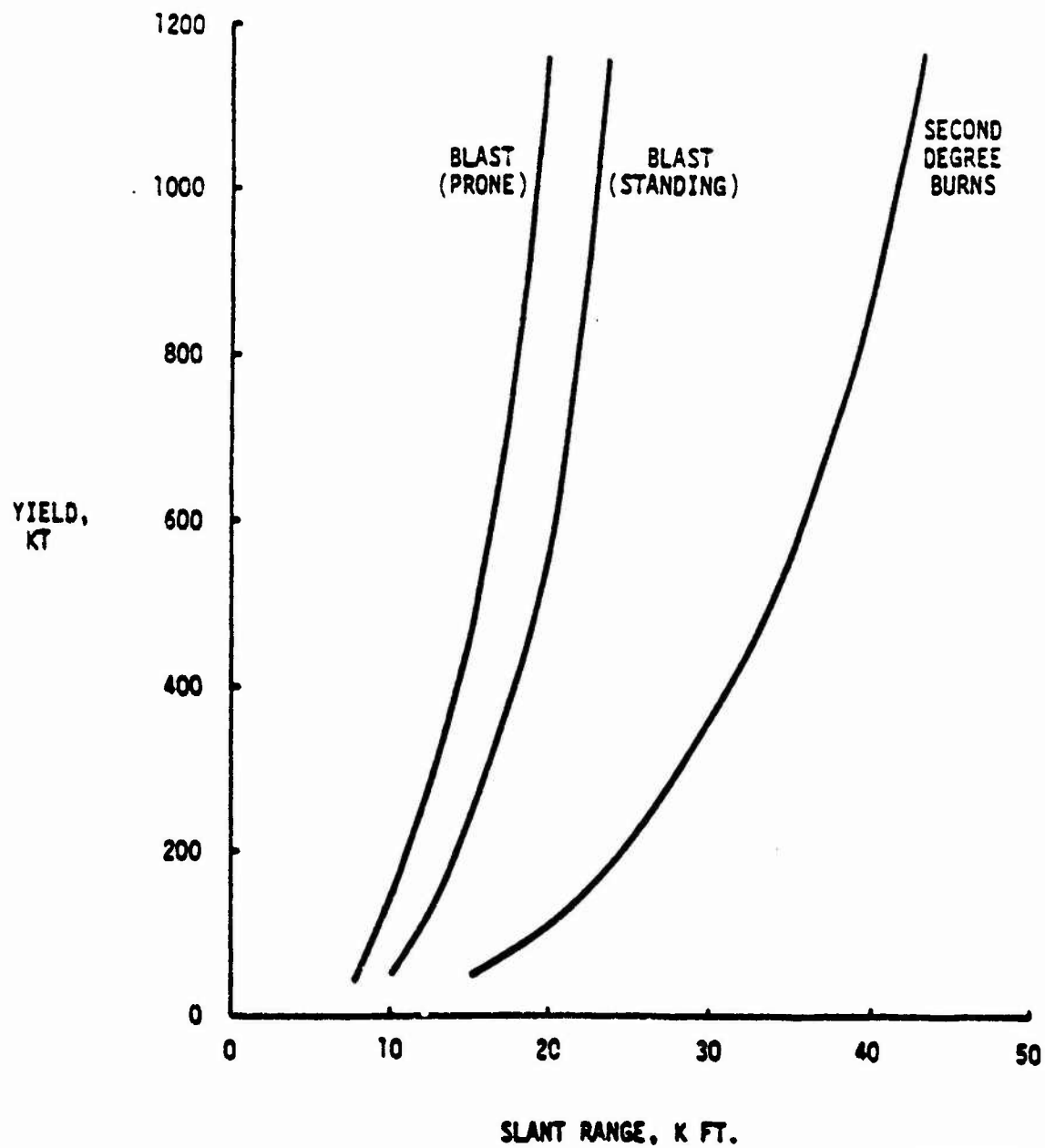


Figure 5-17. Casualty ranges for nuclear weapon effects—troops in open.

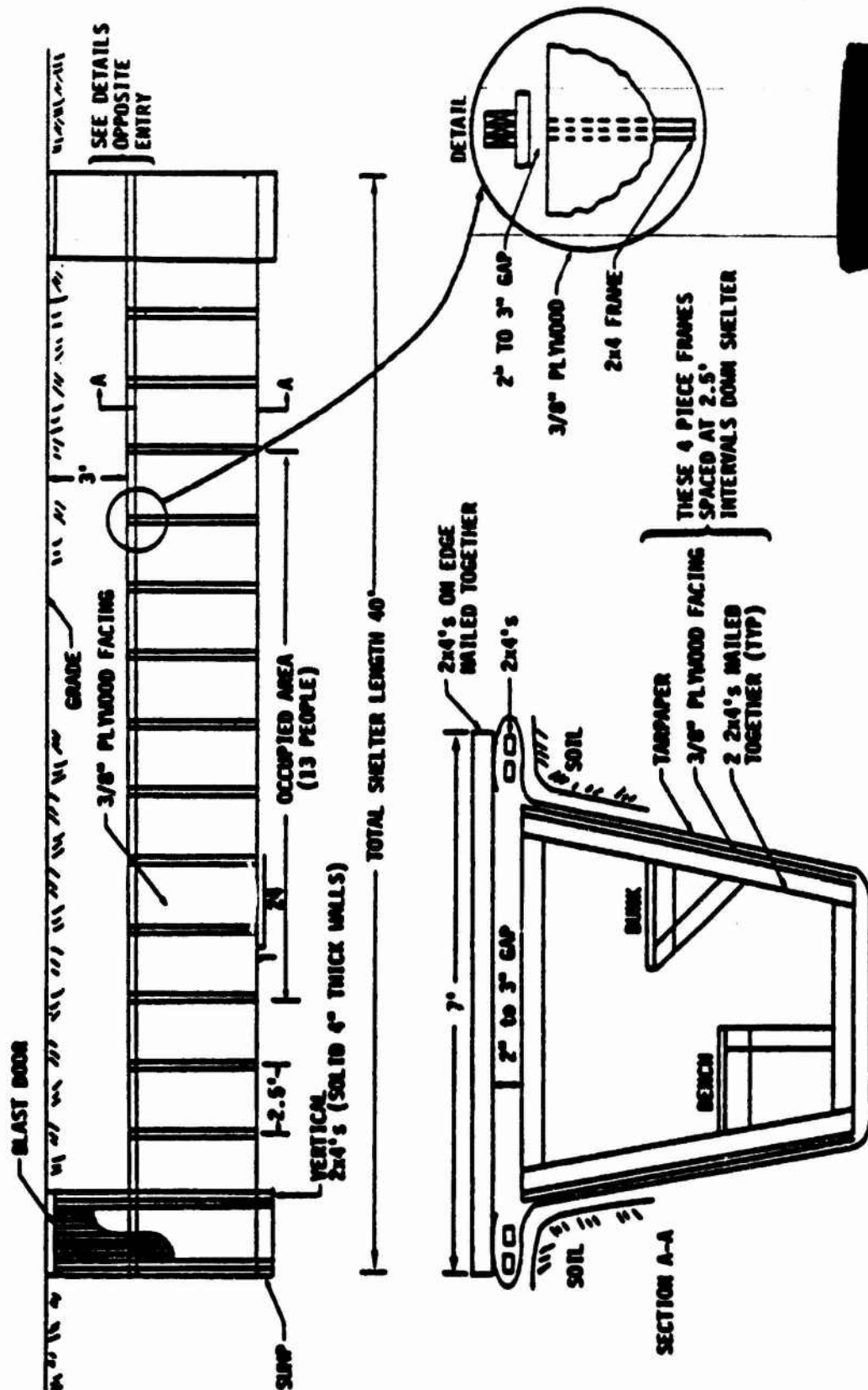


Figure 5-18. Wooden blast shelter (15 psi).



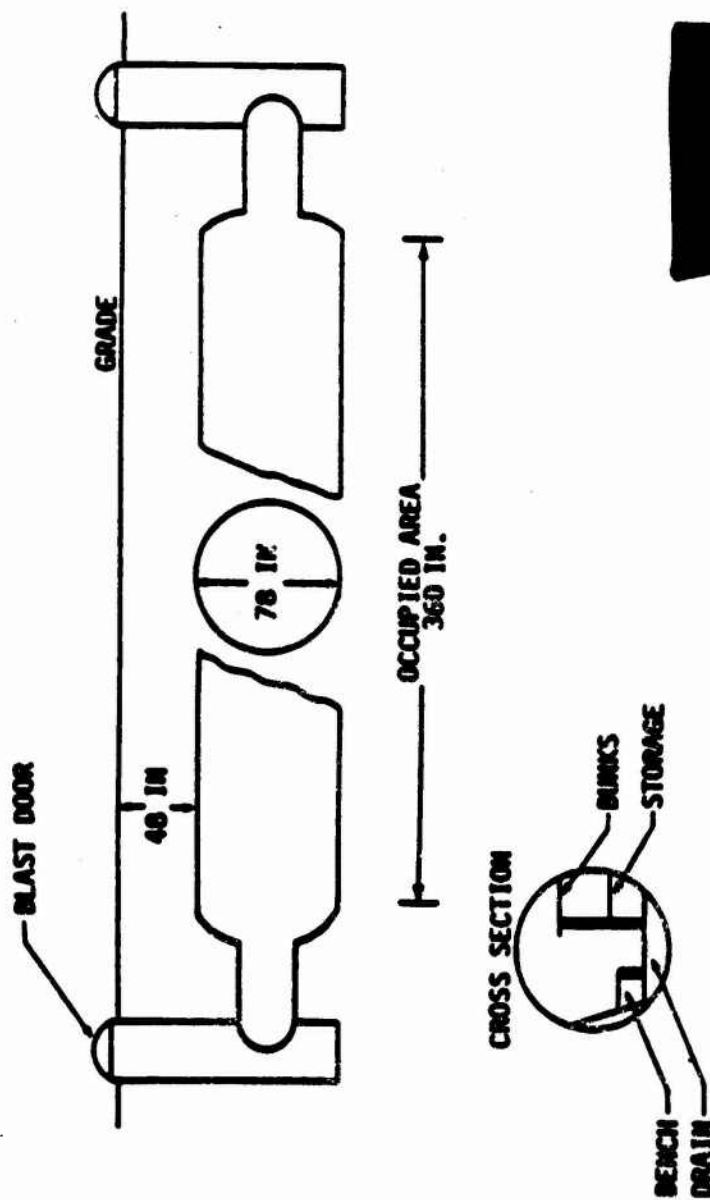


Figure 5-19. Steel blast shelter (50 psi).

[REDACTED]

increase in total dose. For example, at a time (of at most 7 hr.) when the local dose rate has dropped to 360 rads/hr. an exposure of 30 sec will result in an additional dose of 3 rads. (This compares with the sickness threshold dose of about 200 rads.) Frequent removal of radioactive dust from the shelter is necessary.

[REDACTED] One important aspect of shelter construction, i.e., exclusion of ground water, has received insufficient attention in the buried shelter literature to this time. This is probably partly because the field tests have all been in desert areas where ground water has not been a problem. In the second world war, ground water made many British Anderson shelters unusable. These were semi-buried corrugated steel arch shelters with earth floors. Ground water seeped up from below.

[REDACTED] Several approaches can be taken to reduce ground water problems:

1. Choose well drained sites above the water table,
2. Waterproof all shelter joints,
3. Build the shelter above ground and cover with soil,
4. Provide a sump and sump pump.

[REDACTED] A combination of these approaches could be used.

[REDACTED] Prompt Radiation

[REDACTED] Figure 5-20 gives initial dose vs. slant range for the three yields of interest. This is the total dose due to source region gammas, fission product gammas (for about a minute after burst) and neutrons. Figure 5-21 gives the dose transmission factor vs. thickness for 100 lb/cu ft soil. This is the ratio of the total dose inside the shelter to the external dose. For the wood shelter (36" of soil cover) this factor is 0.034 while for steel shelter (48" of soil) it is 0.012. The soil above the wood shelter will shield to well below the sickness threshold dose of 200 rads for any overpressure up to its maximum 15 psi overpressure capability. The steel shelter is capable of withstanding 50 psi structurally.

[REDACTED]

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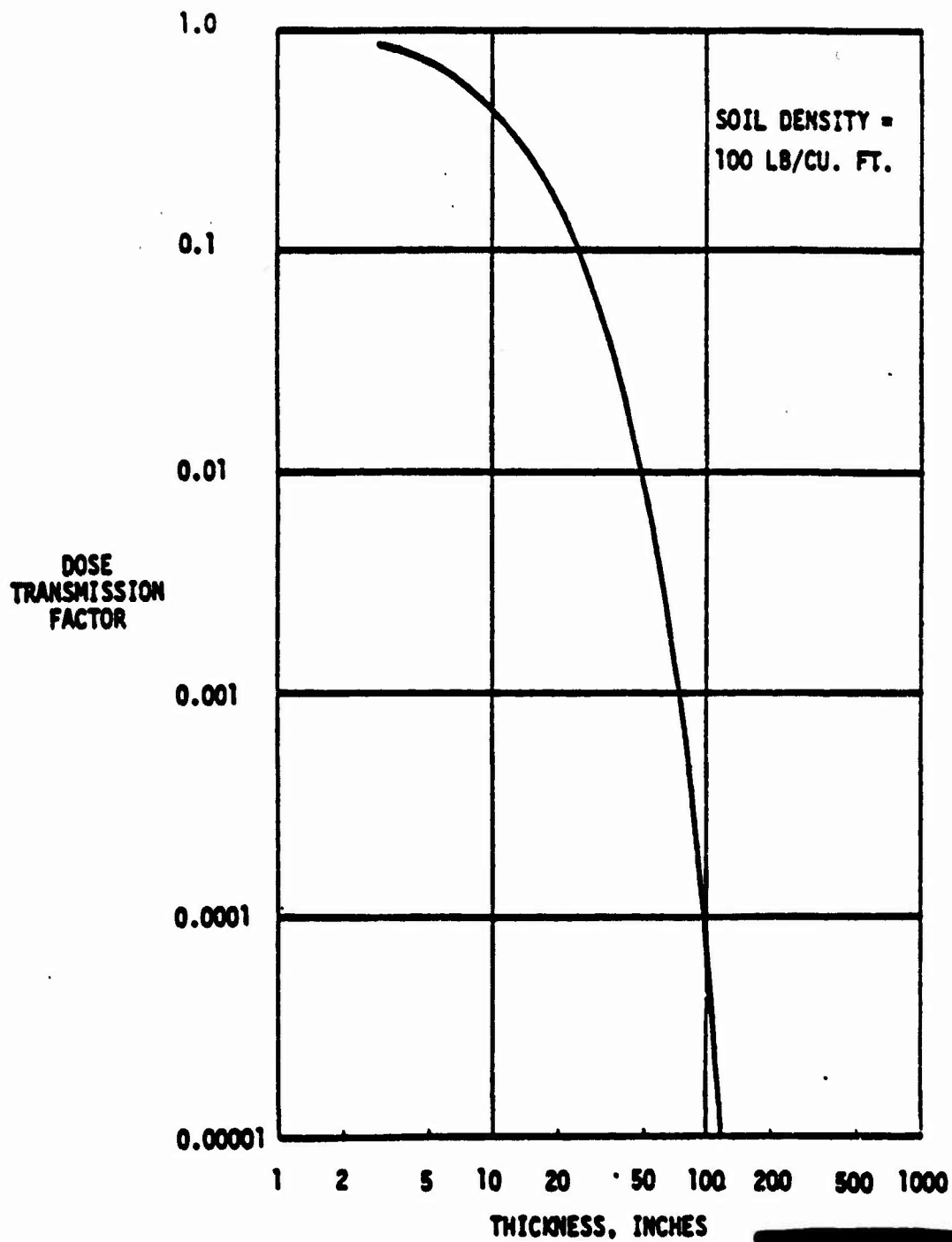


Figure 5-21. Soil shielding from initial gamma radiation.

[REDACTED]

be increased to 60". However, as later shown in the discussion of Table 5-11 these smaller weapons are not effective if shelters are dispersed widely.

[REDACTED] The minimum range for occupant survival for the two shelters and three yields is given in Table 5-10. For the wood shelter this is the 15 psi range while for the steel shelter it is the range to that external dose which will be attenuated to 100 rads internally. The additional doses in the two shelters resulting from "streaming" through the entries was computed and was found to be negligible compared with 100 rads.

[REDACTED] Table 5-10. Minimum ranges from burst to assure shelter occupant survival, ft.

[REDACTED]

[REDACTED] Fallout Radiation

[REDACTED] Consider the case in which the shelter is downwind from a surface burst on a nearby target. It is customary to reference fallout dose rates to a time one hour after burst (H+1 hr). The highest H+1 dose rate seen is about 10,000 rad/hr in the crater region. Since total destruction occurs in this region it is not of interest here. Downwind the highest fallout dose rate is about 5000 rad/hr. That footprint for a 1 Mt surface burst is about 6 mi. long and 1.5 mi. wide. The total fallout dose accumulated in this region is about 25,000 rads. Fallout radiation is far less energetic than prompt radiation, so it is also far less penetrating. For example, the 36" of soil above the wood shelter would attenuate the 25,000 rad external dose to about 10 rads.

[REDACTED] Next consider the required stay time in the shelter to assure that occupants can safely evacuate the shelter to low dose regions. Calculations based on Ref. 15 (using a fission fraction of 1 for the warhead) indicate that occupants of a shelter in the middle of the 5000 rad/hr contour could leave

[REDACTED]

the shelter after 20 hours and pick up less than 100 rads of total dose if they walked out of the contaminated area in one hour. This should not be difficult since only about 15 min. would be needed to reach the nearest point on the edge of the fallout region. A wait of just a few more hours would greatly reduce the total dose.

[REDACTED] This brings out several significant points:

1. On a large base only a small fraction of blast shelters would be expected to see high fallout dose rates.
2. Even those in the heavy fallout region can be evacuated in a day or so.

[REDACTED] Shelter Number and Timing Considerations

[REDACTED] Military bases, whether large or small in total area, generally have a large population in a small built-up area. There should be a shelter keepout zone around the built-up area where shelters would not be expected to survive an attack on the built-up area. For example, if a one megaton air burst is expected, shelters hardened to all weapon effects at the 50 psi range should be emplaced no closer than about a mile from the edge of the built-up area. The distance to the farthest shelters depends on the available escape time. Consider a specific example to illustrate how such distances can be estimated.

[REDACTED] Assume that:

1. About 6,000 on-base personnel are to be evacuated to pre-emplaced shelters,
2. Standard military vehicles (buses, trucks, or armored personnel carriers) are available to evacuate personnel, and
3. Five roads radiate away from the built-up area.

[REDACTED] If about 30 evacuees can be crowded into each vehicle for the brief ride to the shelter then 200 vehicles are needed, or an average of 40 vehicles per departure route. Since the steel shelters also accommodate 30 persons, 200 of these shelters would be needed.

[REDACTED]

■ If each vehicle is assigned a fixed parking spot near its evacuees and a fixed shelter to go to, drills should allow short evacuation times. Significant traffic jams should be avoidable because of the small number of evacuation vehicles. (If at the other extreme two or three thousand cars were used in the evacuation, congestion could be a serious problem).

■ If practice in evacuation drills allows traffic jams to be avoided, it is likely that a shelter located about 8 miles from the heart of the built-up area could be reached in about 15 minutes. If the shelters were spread in a ring between 1 and 8 miles from the built-up area, they would occupy an area of about 200 mi<sup>2</sup> or about one shelter per square mile. Following considerations will show that this area can be sufficient to provide adequate survival. Next consider more specific base types and the increase in the number of warheads required to cause extensive casualties if the on-base personnel are in shelters scattered over the base. Figure 5-22 compares the sizes of typical Army, Air Force and Navy installations. Using ground ranges from Table 5-10, Table 5-11 gives approximate numbers of warheads needed to produce about 70% casualties.

■ Because The Air Force and Navy installations are much smaller than the Army bases they require far fewer warheads for coverage. However, use of shelters, and particularly the steel shelters, would significantly increase warhead requirements even for these smaller targets. If steel shelters are scattered over the large (170 mi<sup>2</sup>) Army fort, many warheads would be required. In general if personnel can reach steel shelters scattered, on or off base, over an area of about 100 mi<sup>2</sup>, it will not represent a profitable target.

■ In times of high stress but when attack is not imminent, off duty personnel could be sheltered or taken well away from potential aim points. Many key personnel could perform their duties from shelters well away from the central area of the base.

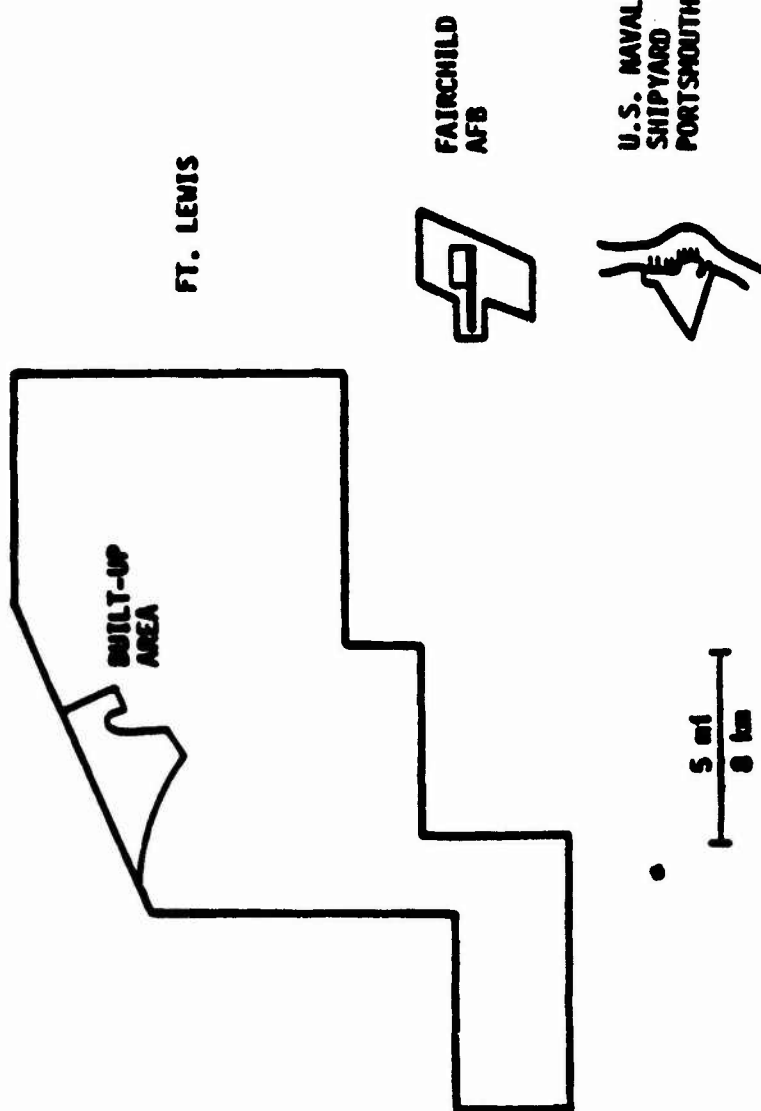


Figure 5-22. Comparison of base sizes.

[REDACTED]

Table 5-11. Number of warheads needed to produce about 70% casualties.

SHELTER TYPE AND TYPICAL INSTALLATION	Warhead Yield, kt
Wood Shelters	[REDACTED]
USAF base	
Navy shipyard	
Army Base	
Steel Shelters	
USAF base	
Navy shipyard	
Army base	

[REDACTED] The preceding discussion, which showed the dispersal areas required to prevent the base from becoming an "attractive target" is correct only insofar as personnel themselves are concerned. The base likely is targeted primarily because of the facilities, weapons systems and function it contains. To the extent that military personnel are a part of the function they are, of course, a target. For these reasons shelters probably should be built to provide protection against attacks primarily designed to destroy the facilities and functions at the base, not attacks which deliberately try to attack with such intensity as to ensure a high level of personnel fatalities. Such attacks cannot readily be countered individually. However, as noted earlier, when protection is provided on a large scale then, the synergism of multiple systems all demanding extremely high attack levels for high probability of kill will collectively negate an attack. Thus, what is really needed are shelters with a moderate level of blast protection and a high level of fallout attenuation uniformly distributed and highly proliferated at or near all military installations.

### 5-3.3 [REDACTED] Air Surveillance of Contiguous Waters (Future Work Outlined)

[REDACTED] The prevention of invasion of U.S. and neighboring territories will be a major military function in the defense of the homeland. The potential for landing of Soviet Union troops for the occupation of strategic areas or



[REDACTED]

landing of paramilitary units for physical or political sabotage must be anticipated, and capability to prevent it must exist. Such invasions may arrive either by air or sea. The discussion of air defense in Section 5-3.1 addressed primarily defense against bombers and cruise missiles. That same capability could repel air transport. Surveillance of contiguous waters will address intrusions by surface vessels as well as submarines. The latter pose a multiple threat in that they can put ashore small paramilitary type units, interfere with U.S. shipping and launch strikes against U.S. targets inland.

[REDACTED] Patrol aircraft capable of monitoring sea traffic must be retained after the initial nuclear attacks on military facilities. Since seaborne movements are considerably slower than those of aircraft, it will not be necessary to maintain continuous surveillance. It will, however, be required to coordinate the surveillance cycles with the response capability of defense systems so that effective interception will be possible.

[REDACTED] A major portion of contiguous waters surveillance will be the submarine patrol which will have to include thorough searches of contiguous waters as well as the capability to penetrate and search remote bodies of water (e.g. Hudson Bay or Gulf of St. Lawrence) should that become necessary. Specific details of system requirements for air surveillance of contiguous waters during the protracted war have not been addressed in this investigation. They constitute, however, a significant aspect of military missions relating to homeland defense and need to be developed further.

#### 5-3.4 [REDACTED] Enemy Surveillance Denial (Future Work Outlined)

[REDACTED] A major requirement for the successful conduct of a protracted war is to know more about the enemy's situation and actions than he knows about ours. This applies, of course, to all military missions during such a conflict but primarily it is important to create a sanctuary within the homeland where military and economic recovery actions are initiated. The assessment of the attack effectiveness (Section 3-3) indicates the likelihood that both nations will have destroyed each others space based surveillance capability. This would include assets in space and also the ground based tracking and data receiving and processing facilities. Without space tracking capability it

[REDACTED]

will be impossible to remain aware of replaced satellites and hence prevent surveillance.

[REDACTED] This leads to requirements for the capability to prevent surveillance of the homeland from sensors in space. The section on Air Defense (5-3.1, above) considers the need to prevent reconnaissance overflights. Thus two types of capabilities are needed during the protracted conflict, i.e., the ability to detect surveillance sensor and data handling system activity, and the weapon capability to prevent effective surveillance. Conceptual ideas for satellite detection and tracking systems usable during protracted conflict need to be developed as well as systems to destroy the surveillance capability when it is detected, or, failing that, develop techniques for avoiding surveillance by monitoring its passages. Development of these concepts is left for future investigations.

#### 5-3.5 [REDACTED] Attack Warning (Future Work Outlined)

[REDACTED] The initial attack is expected to destroy all of the existing attack warning systems either in the course of the attack or by special action immediately preceding it. This then could leave the U.S. without warning of any further attacks by Soviet Union strategic weapons. The above discussion of Air Defense (Section 5-3.1) addressed the need for warning of bomber attacks during the protracted war. There are currently no enduring systems which could warn of ICBM or SLBM attacks. The discussion in Section 5-3.3 on contiguous waters surveillance concerned systems which would be capable of tracking Soviet Union submarines. They would, however, be inadequate for launch warning.

[REDACTED] In the discussion of replenishable satellites in Section 5-4.2 the needed capability for launching satellites for information gathering is described. It appears that sensors in Molniya as well as geostationary orbit could detect ICBM launches from known locations in the Soviet Union. A capability to monitor the ocean areas from which SLBM attacks could be expected may be found to be too costly for the value they provide. These questions need to be addressed further but are beyond this study.

The prime support function of all military missions before and after initiation of the war is the gathering of information, the interpretation, and dissemination for commands in response to the situation assessment. In recognition of the value of this function the assumption was made in the analyses of Section 3-0 that both antagonists would exert special efforts to destroy the other's capability to gather and make use of critical information. Hence, space and ground based sensors will be attacked, as well as data processing and command center facilities. Both nations have existing, highly redundant civilian communication systems, and the assumption is that an attack on military facilities only, will leave much of that intact making it possible to restore a minimum capability soon.

The more critical components are the parts of the C<sup>3</sup>I structure used for gathering and interpreting information. They depend upon very sensitive equipment and highly trained personnel. Two ideas are presented here which deal with the retention and restoration of those aspects of C<sup>3</sup>I. They address specifically concepts for protection of C<sup>3</sup>I system support personnel and for the post attack launch of replacement satellites for communications relay, attack warning and surveillance of enemy (world wide) activities.

#### 5-4.1 Survivable C<sup>3</sup>I Support Concepts

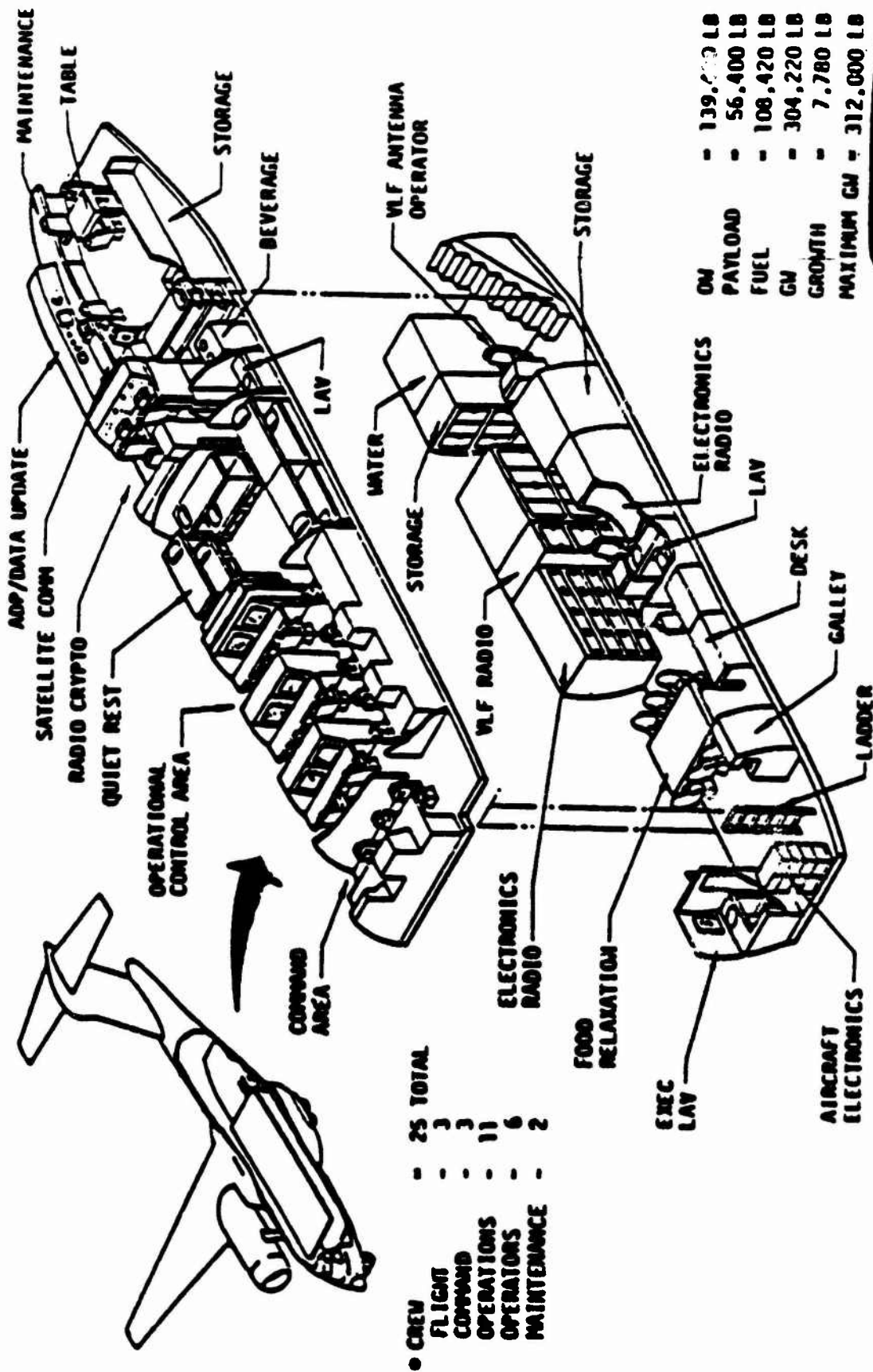
This conceptual idea deals particularly with trans- and post-attack protection of critical C<sup>3</sup>I support personnel. It recognizes that in addition to the other constituents of the global C<sup>3</sup>I system structure, the enduring survival of highly trained and experienced C<sup>3</sup>I specialists is of importance and can be provided for by the suggested techniques. The development of these concepts begins by assessing the types of people (by function, experience and training) who are supporting the C<sup>3</sup>I systems.

The C<sup>3</sup>I personnel can be divided into two categories: the large group of support and logistic personnel who do not function directly in-line with weapon system operations but are required for reconstitution, and the smaller group who function real time in-line with weapon systems operations

[REDACTED]

through attack, and near real time in the protracted war periods. Elements of the former category are located on bases throughout CONUS. Concepts for their survivability and endurance are discussed in Section 5-3.2, Military Base Protective Measures. The latter category is subdivided into three groups. First there are the weapons controllers. Their survivability and endurance is achieved through weapon system design and operations, e.g., Minuteman hardened launch control center and ALCC's, the submerged submarine, the cruise missile carrier and bomber mobility. The second group consists of the top command authority, e.g., NCA and CINC's. Their survivability is taken to be achievable through air mobility using WAABNCP E-4 and EC-135 aircraft. Limited functional endurance is projected by employing air-to-air refueling and "on-ground" operational capability. However, the present WAABNCP aircraft require long runways (6000 to 10,000 ft) which, because they are few in number, can be targeted. It has been suggested that improvement in top command survivability and endurance can be achieved through use of medium size wide body STOL aircraft, e.g. C-14. Such aircraft could function from 3000 ft. runways, some 5000 of which are available within CONUS, or from highways, unprepared fields and the like. The aircraft and C<sup>3</sup>I payload would be designed for on-ground operations to conserve fuel. Water and food would be provided for a crew live-aboard capability. A concept configuration for such a CINC command aircraft is shown in Figure 5-23 and detailed information is contained in Boeing document D180-24755-1; "Survivable C<sup>3</sup>I Systems Based on AMST Aircraft", Aug. 9, 1978.

[REDACTED] The third group of the latter category is identified as the cadre of "key" support personnel required by the NCA to effect positive weapon system command and control under the attack and protracted war scenario. Such support has become increasingly necessary because of the complexity and diversity of the strategic forces and the shift in war emphasis from single all out attack to limited attack and indefinite protracted operations. The group consists of "key" people with special skills and weapons control backgrounds. Some of these personnel categories and their supportive tasks are listed in Table 5-12. Survivability and functional endurance for this group constitutes a special case: the group is large and dispersed throughout CONUS, but not so large and dispersed that the group could not be targeted even under "low level attack" scenarios; their supportive functions are



• CREW	-	25 TOTAL
FLIGHT	-	3
COMMAND	-	3
OPERATIONS	-	11
OPERATORS	-	6
MAINTENANCE	-	2

DN	-	139,000 LB
PAYLOAD	-	56,400 LB
FUEL	-	108,420 LB
GN	-	304,220 LB
GROWTH	-	7,780 LB
MAXIMUM GN	-	312,000 LB

Figure 5-23. Command and control STOL aircraft configuration.

Table 5-12. Key C<sup>3</sup>I support personnel.

TYPES	TASKS
<ul style="list-style-type: none"> <li>• COMMUNICATIONS AND TECHNICAL CONTROLLERS</li> </ul>	<ul style="list-style-type: none"> <li>• IDENTIFY/ESTABLISH COMM. LINKS BETWEEN NCA/CINC's WEAPONS</li> <li>• EFFECT RECONSTITUTION OF COMM. NETWORKS</li> </ul>
<ul style="list-style-type: none"> <li>• CRUISE MISSILE CARRIER/BOMBER OPERATIONS SUPPORT</li> </ul>	<ul style="list-style-type: none"> <li>• MAINTAIN AIR BREATHER FORCE DATA BASE</li> <li>• SUPPORT NEAR TERM OUTBOUND/HOLD/RECOVERY OPERATIONS</li> <li>• EFFECT FORCE RECONSTITUTION</li> <li>• PLAN/SUPPORT PROTRACTED WAR OPERATIONS</li> </ul>
<ul style="list-style-type: none"> <li>• ICBM/SLBM, OPERATIONS</li> </ul>	<ul style="list-style-type: none"> <li>• MAINTAIN MISSILE FORCE DATA BASE</li> <li>• DIRECT FORCE EXECUTION PER NCA</li> <li>• EFFECT FORCE RECONSTITUTION</li> <li>• PLAN/SUPPORT PROTRACTED WAR OPERATIONS</li> </ul>
<ul style="list-style-type: none"> <li>• FORCE RESPONSE ANALYSIS AND WEAPONS TRAJECTORY/TARGETING TEAMS</li> </ul>	<ul style="list-style-type: none"> <li>• EVALUATE NEAR TERM AND PROTRACTED WAR ALTERNATIVES</li> <li>• SUPPORT PROTRACTED WAR OPERATIONS</li> </ul>
<ul style="list-style-type: none"> <li>• INTELLIGENCE TEAMS</li> </ul>	<ul style="list-style-type: none"> <li>• EVALUATE RESULTS OF FRIENDLY AND ENEMY ATTACKS</li> </ul>
<ul style="list-style-type: none"> <li>• LOGISTICS</li> </ul>	<ul style="list-style-type: none"> <li>• LOCATE SURVIVING SPARES AND MAINTENANCE ABILITY</li> <li>• EFFECT FORCE READINESS THROUGH PROTRACTED WAR PERIOD</li> </ul>

[REDACTED]

required by the NCA on a near real time basis; selective hardware, software, data bases and communications must survive along with the personnel. The survivability concept which follows addresses the special needs of this "key" group of support C<sup>3</sup>I personnel. It is applicable to similar functional groups which require high confidence survivability and endurance, e.g., key weapon system logistic personnel.

#### 5-4.1.1 [REDACTED] Survivability Concepts

[REDACTED] Two concepts appear suitable for achieving the survivability of the groups of support C<sup>3</sup>I personnel. The first utilizes redundant nearby off-base hardened shelters with prepositioned equipment and supplies, and the second utilizes road mobile transports which can carry the key personnel/equipment away from pre-established, dispersed sites. The rationale which supports this contention is outlined in Table 5-13. It is envisioned that some integrated combination of these two concepts would be implemented for each particular base and specific functional responsibility.

#### 5-4.1.2 [REDACTED] Hardened Off-Base Shelters

[REDACTED] The first of the suggested concepts: the Hardened Off-Base Shelter, is shown in Figure 5-24. Near an operational C<sup>3</sup>I base a number of shelters are constructed of such hardness and dispersion that the base and each shelter must be considered as separate aim points. Earth covered concrete and steel construction for 40-100 psi protection is envisioned, the shelter door being the most critical item. Individual shelter hardness would be tailored to the site requirement, taking into consideration terrain, distance from the base, soil condition, and other factors.

[REDACTED] On initial warning or at high DEFCON levels the key C<sup>3</sup>I personnel would move to one of the shelters using standby road transport (described later in this report) and reestablish support operations for as long as required. Each shelter would be preprovisioned with fuel and life support elements for a designated period, e.g. 30 days. Nuclear radiation, chemical, and bacteriological protection will be provided. The current data base, and

**Table 5-13. Identification of candidate survivability concepts.**

<ul style="list-style-type: none"> <li>● Approaches for Achieving Survivability               <ul style="list-style-type: none"> <li>● Hardening</li> <li>● Mobility</li> <li>● Redundancy</li> <li>● Disperse on Warning</li> </ul> </li> <li>● Deception - Not Practical for Large Groups</li> </ul>	<p>Applicable to Problem Solution</p>
<ul style="list-style-type: none"> <li>● Survivability Concepts               <ul style="list-style-type: none"> <li>● Sea</li> <li>● Space</li> </ul> </li> <li>● Airborne - Costly for Large Dispersed Groups, Lack of Endurance</li> <li>● Deep Underground - Cost and Lack of Survivable, High Data Rate Communication Links</li> <li>● Ground Mobility</li> <li>● Dispersed Sites</li> </ul>	<ul style="list-style-type: none"> <li>● High Cost</li> <li>● Difficult to Translate From Peace to War Operations</li> </ul> <p>Applicable to Problem Solution</p>
<ul style="list-style-type: none"> <li>● Candidates Concepts               <ul style="list-style-type: none"> <li>● Redundant Off-Base Hardened Shelters</li> <li>● Road Mobile Transports</li> <li>● Redundant Soft Shelters</li> <li>● Off-Road Mobile Transports</li> </ul> </li> </ul>	<p>Suggested for Further Development</p>



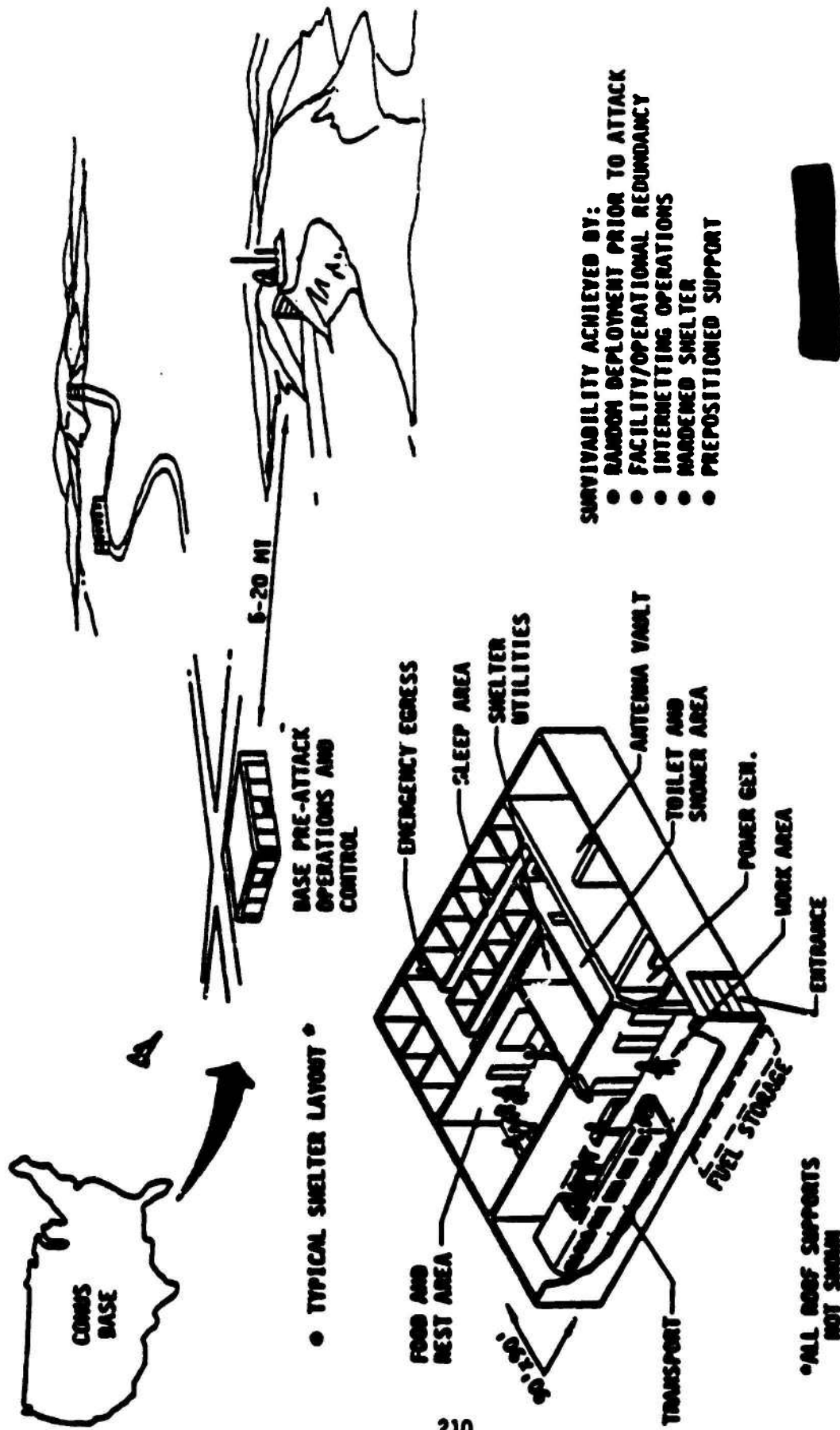


Figure 5-24. Concept: Hardened off-base shelter facilities.

[REDACTED]

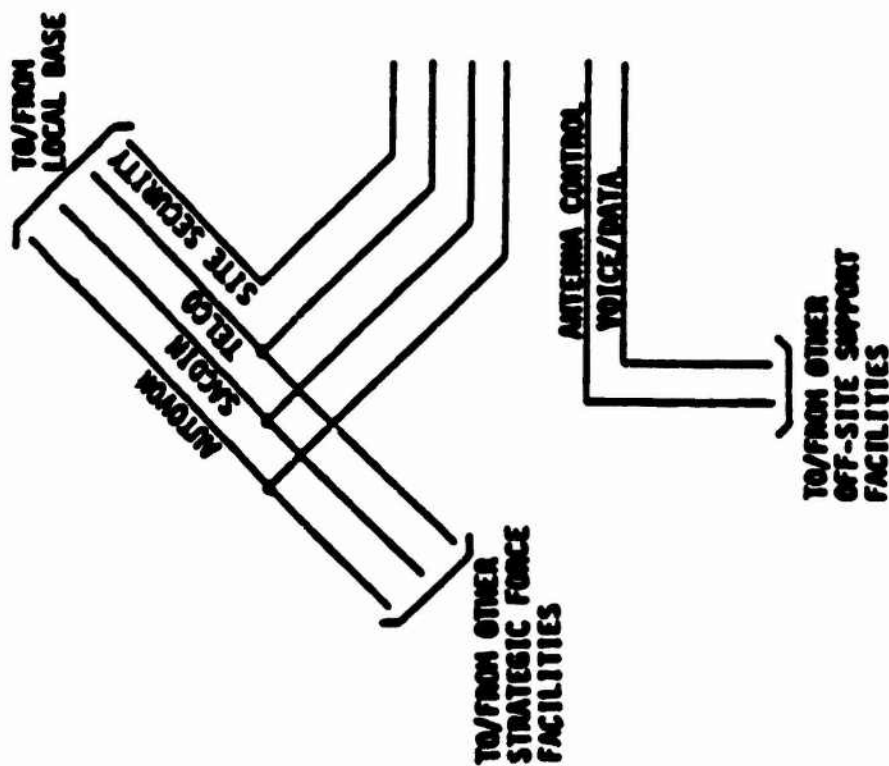
high cost support hardware/software items also would be brought to the shelter by the the transport vehicles.

[REDACTED] Each shelter would serve as an independent communication node and would be equipped with a landline and hardened antenna set as outlined in Figure 5-25. The communication equipment would be connected to shelter power and the landline and antenna terminals on entry. Communication links with NCA, weapons control points, or other sheltered support groups could be established, or reconstituted, within minutes. the antenna capability would remain survivable due to hardness, redundancy, and exposure only as required. It would be possible for an occupied shelter to deploy and utilize antennas of unoccupied shelters thereby confounding enemy reconnaissance efforts to locate the sheltered key personnel.

[REDACTED] With this concept survivability of key personnel, data base, hardware/software, and the supporting function is achieved specifically through redundant, presupplied hardened shelters occupied on warning. A variation of this shelter concept also can provide protection against loss due to surprise if during peacetime, a random selection of shelters were occupied at all times with operations being executed through the normal base operations.

[REDACTED] The hardened shelter concept has some specific advantages. Most important is the fact that few new people would be required since the plan is that existing key personnel would support both the base peacetime and the wartime shelter operation. This is based on the fact that the shelters are located within minutes of base operations and because the shelter would be able to provide a comfortable and efficient off base work space during a high DEFCON preattack condition. Further, the operational capability afforded through the shelter concept is maintainable at high levels over an extended period of time. This is achieved by prepositioned supplies and accommodations for a 24 hour crew size and the possibility for resupply. The principal disadvantage of the shelter concept is that its position is known and can be targeted. This can be countered by shelter proliferation and reducing the per shelter value.

• BRIDGED LANDLINE SYSTEMS



• RADIO SYSTEMS

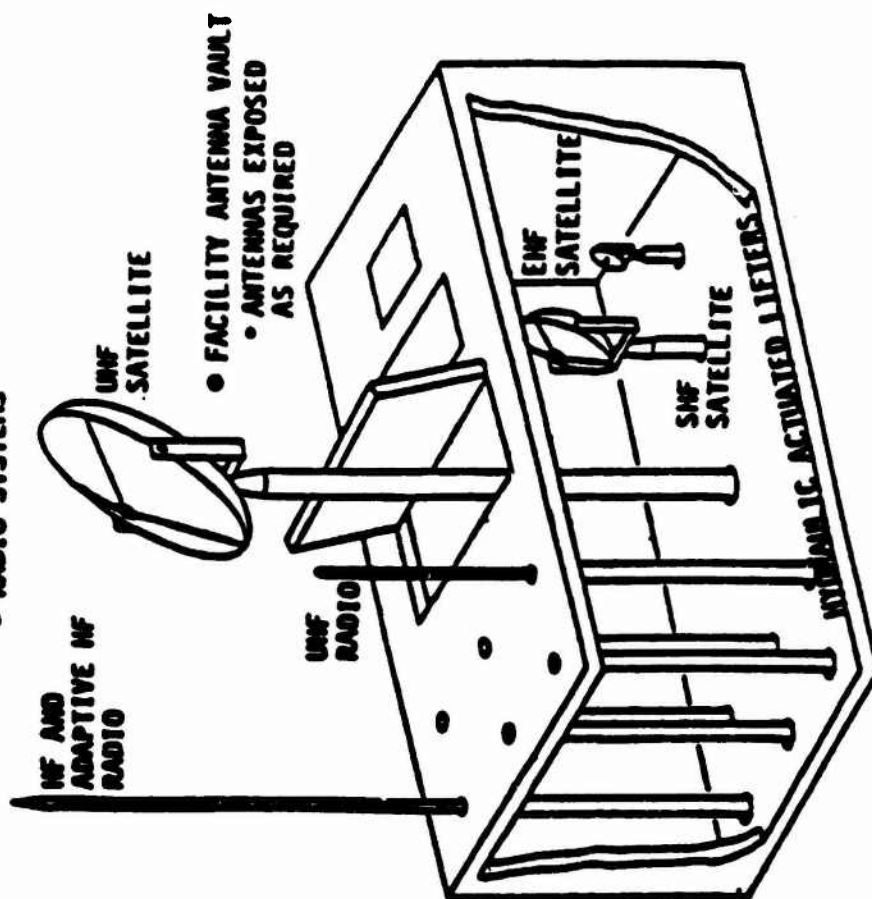


Figure 5-25. Shelter communications.

#### 5-4.1.3 [REDACTED] Road Mobile Transports

[REDACTED] The alternate concept based on the use of road mobile transports is shown in Figure 5-26. The central element is the self contained transport including a number of key personnel, and the data bases, electronics, and communication equipment as required to support their assigned function. The transport is designed to afford EMP and radiation protection, and limited life support for operations and driver crew.

[REDACTED] Survivability is achieved by movement to off-base locations, outside/upwind of potential target areas. The transport would not remain in an area long enough to be detected and targeted. Some percentage of the transports with key personnel could be deployed on the road during times of high stress to preclude loss of all functional capability with surprise attack.

[REDACTED] Theoretically the transport could be parked anywhere alongside the roadway and operations could proceed. As a practical matter this may not be so, and some number of off base parking sites will have to be provided in some CONUS areas to guarantee parking, toilet, water, and rest areas, especially for the peacetime operation.

[REDACTED] The principal advantage of this concept is that it is inherently quite survivable because individual transports would be difficult to detect and target. But there are also some negative aspects. Transport survivability cannot be dependent on dash-on warning as the public roads, under attack conditions, may be jammed with civil and military vehicles. The post attack endurance of the mobile units will be limited to a few days if crews cannot be rested, and life support and fuel resupply not obtained. Long term C<sup>3</sup>I functional availability through the mobile concept, that is days and weeks, would be dependent on reaching prepositioned supplies of food, fuel, and water. The concept of operation also results in an increased requirement for trained key personnel, since some personnel must be on-the-road at all times and thus cannot be at-the-base performing a normal peacetime function.

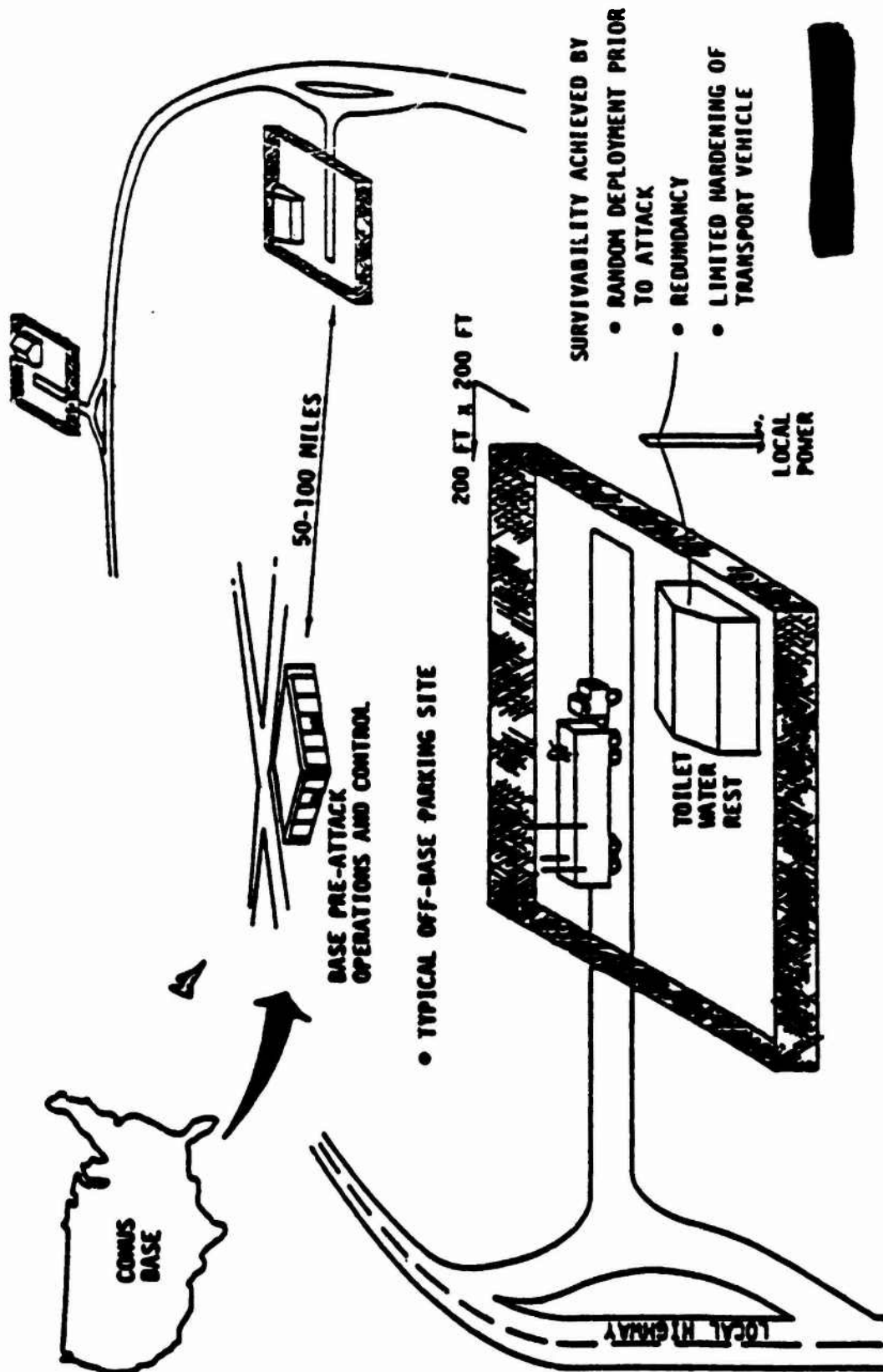


Figure 5-26. Concept: Road mobile transport.

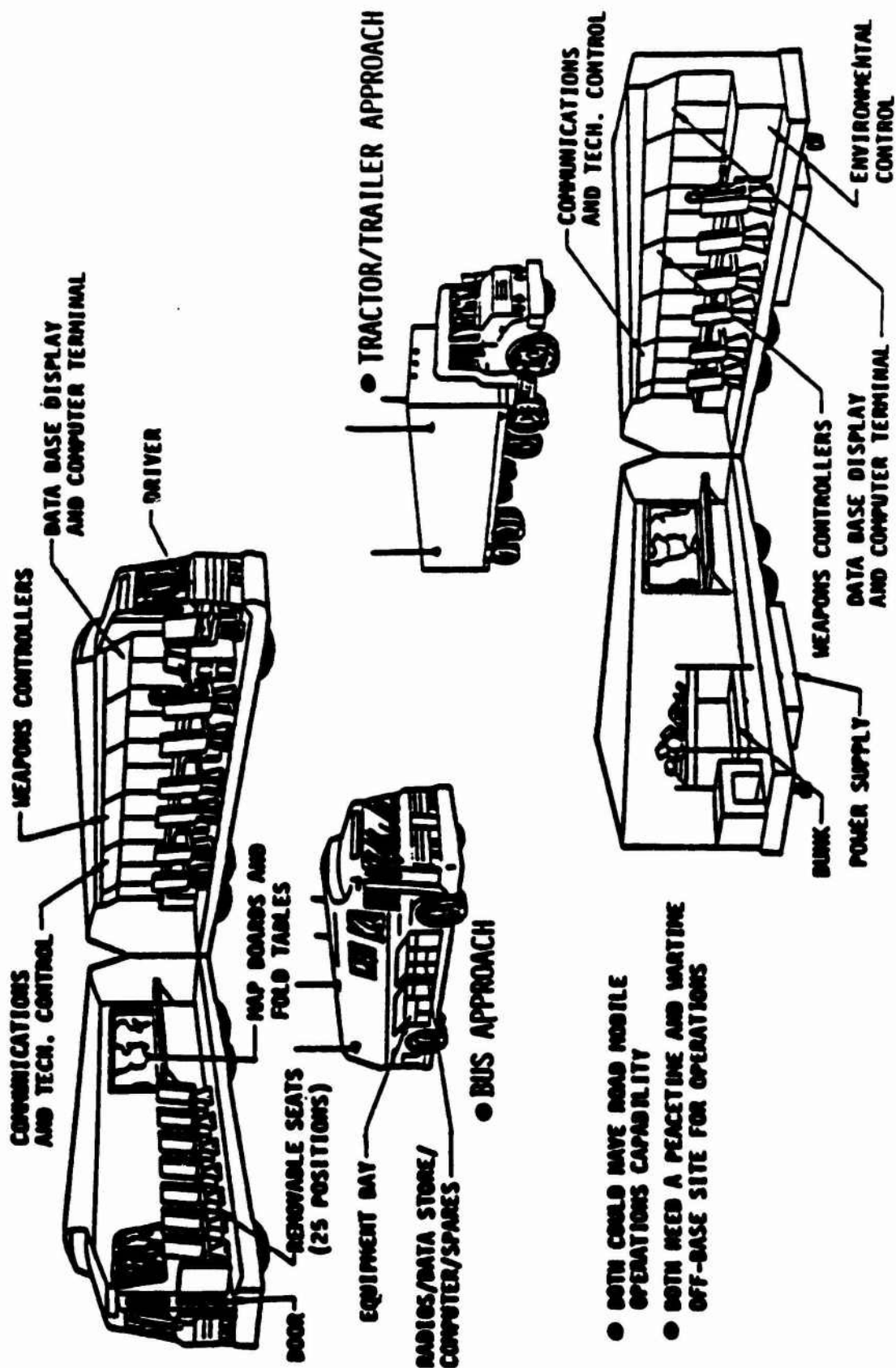
#### 5-4.1.4 [REDACTED] Transport Concepts

[REDACTED] Two transport concepts are identified on Figure 5-27. One configuration is based on use of a 40 foot bus and the other on use of a trailer and tractor. Each transport is configured as a mobile office with a six position console. Radio, data storage, and data processing electronics, and associated spares and power supplies are included. The bus approach appears well suited to the shelter survivability concept since it could dash with a load of 25 or more people and need not be hardened for EMP or radiation protection. But either approach could be adapted to the requirements of either the hardened shelter or road mobile approach. Table 5-14 provides a preliminary understanding of a bus and a trailer-tractor payload as configured for the shelter or on-road survivability concepts.

#### 5-4.1.5 [REDACTED] From Concept to Practical Application

[REDACTED] A single fixed approach to survivability and operational endurance of key personnel/key functions is not suggested. The key personnel, data bases, and the functional capabilities which must survive the attack and endure and support protracted war operations for an indefinite period are located on a number of bases throughout CONUS. The contribution to the total survivable C<sup>3</sup>I function from each base will be unique with respect to function, personnel and equipment. Road patterns and geographic perspective will be different at each base.

[REDACTED] As a practical matter the more reasonable approach for achieving survivability and endurance is to employ standardized "building blocks" developed from both the hardened shelter and road mobile concepts previously discussed. The "building blocks" would be assembled in quantity and format to best suit the survivability and endurance needs of a particular base function, location, and key personnel requirement. For example, for those responsible for bomber and cruise missile carrier reconstitution/turn-around, an emphasis on mobility and less dependence on real time communications is required. The capability to communicate with bombers and cruise missile carriers, to direct such aircraft to austere bases, set up landing aids, direct/coordinate weapons/fuel reload, and report status to NCA would be provided to the key



- BOTH COULD HAVE ROAD MOBILE OPERATIONS CAPABILITY
- BOTH NEED A PEACETIME AND WARTIME OFF-BASE SITE FOR OPERATIONS

Figure 5-27. Personnel and mobile office transport.

Table 5-14. Preliminary transport payload definition.

	Shelter Concept			Road Mobile Concept		
	Number	Weight	Power	Number	Weight	Power
Communications						
VLF Receiver/Printer	1	100 Lbs.	100 Watts	1	100 Lbs.	100 Watts
HF AM/ABC-190	1	150	2000	1	150	2000
Adaptive HF/VHF	2	350	4000	2	350	4000
UHF ABC-164	2	150	1200	2	150	1200
Hard Copy Printer	1	50	100	1	50	100
Surface Antenna Set	-	-	-	1	200	50
Satellite Antenna Set	-	-	-	1	400	200
Computer/Data Base						
Computer/Bulk Store	1	250	500	1	250	500
Keyboard/Display	2	150	800	2	150	800
Electronic Spares	-	500	-	-	500	-
Consoles	6	5000	500	6	5000	500
Life Support	-	-	-	1	5000	1000
EMP/Radiation Hardening	-	-	-	-	1000	-
Power Supply	-	-	-	1	500	-
Fuel	-	-	-	1	150	-
Acillary	-	2300	-	-	2050	-
TOTAL		<u>9,000 Lbs.</u>	<u>9,200 Watts</u>		<u>16,000 Lbs.</u>	<u>19,450 Watts</u>



[REDACTED]

personnel for this facet of survivable C<sup>3</sup>I. Personnel responsible for evaluation of force responsive alternatives or retargeting need little mobility. These key people do require near real time communications with NCA and weapons controllers and a long term survivable "office" to preserve and update large data bases and perform analytical operations. Those responsible for naval forces resupply will require a survivable "office" and survivable communication to both military and civilian organizations. The key personnel would be provided with a capability to build a new data base identifying surviving port and transport facilities. Survivable transport would be provided to allow travel to a port location to organize and direct both civil and military units in the resupply effort. Communication, shelter, life support, transport and other "building blocks" from the hardened shelter and road mobile concepts would allow definition of cost effective solution of the survivability and endurance requirements for diverse groups of key personnel located over broad geographic areas. Further, the nonconformity of the result would confound an enemy attempt to counter by a "singular approach" attack.

[REDACTED] The practical application of the concepts for the survivability and endurance of key personnel is then envisioned as number of transport, shelter, and prepositioned equipment and supplies tailored to the particular tasks required and the geographic areas of operation. Communications would be provided to support both civil and military functions. Need for unique and complex equipment would be deemphasized as this is not compatible with long term endurance requirements.

#### 5-4.1.6 [REDACTED] The Next Step

[REDACTED] The next logical step in the process of the development of survivable and enduring C<sup>3</sup>I is to obtain a quantitative definition of the functions which must be performed trans- and post-attack and an identification of the key personnel who will perform or ensure that these functions are completed in a timely manner. Such information can be developed from attack and protracted war scenarios and from an understanding of NCA and weapon system operations. Next it is required to identify the peacetime organizations containing the key personnel. An understanding of peacetime operations is required for development of a workable plan for transfer from peacetime to wartime operations.

[REDACTED]

The communications capability, and support hardware/communications capability, required by the key personnel must be defined. The local geography must be understood. Integration of these data will then allow detailed definition of a surviving C<sup>3</sup>I function responsive to the specific needs of specific organizations at specific locations.

[REDACTED] When viewed from the total military survivable and enduring C<sup>3</sup>I requirements, this "next step" is very large, probably too large to "get your arms around." It is suggested that the task begin with one part of the overall job, perhaps survivable and enduring C<sup>3</sup>I for the Air Force missile and air-breather strategic force.

#### 5-4.2 [REDACTED] Replenishable Satellites

[REDACTED] The probable initial phases of the countermilitary attack will see a nearly complete loss of space based intelligence gathering, and communications systems. Platforms placed into earth orbit subsequent to the destruction of the ground based telemetry and tracking capabilities will probably be quite safe from attack. However, they must be autonomous since control from the ground cannot be assured. The following addresses briefly which critical systems will be subject to destruction at the beginning of this war and then describes concepts for replacing their capability during the protracted war.

[REDACTED] The major space based systems which are expected to be lost include:

- 1) Global Weather Information,
- 2) Communication relay (e.g. SATCOM),
- 3) Navigation Aids,
- 4) NUDET Detection,
- 5) Missile Attack Warning, and
- 6) Photo Reconnaissance.

[REDACTED] Some of these capabilities will be lost even if only the ground based control facilities are incapacitated. Without orbit control of space platforms and ability to receive wide band high rate data transmissions anticipated degradation will be:

- [REDACTED]
- 1) Immediate loss of global weather information with local weather information degrading over weeks,
  - 2) Gradual loss of AFSATCOM in 1-2 weeks,
  - 3) 90% immediate loss of SHF SATCOM because of the loss of large antenna terminals with complete loss in 2-4 weeks,
  - 4) Loss of NAVSAT services in a month,
  - 5) Immediate loss of E/H and W/H NUDET,
  - 6) Immediate loss of satellite missile warning,
  - 7) Immediate loss of Photo Reconnaissance.

[REDACTED] It is clear that some of these services can be restored by the use of replenishment satellites. The utility of several replacement satellites will now be described.

#### 5-4.2.1 [REDACTED] Replacement Satellite Concepts

[REDACTED] The following is a description of concepts for replacement satellites for several critical functions identified above.

##### [REDACTED] Global Weather Satellites

[REDACTED] The peacetime weather system consists of space and ground based segments. The space element consists of two spacecraft in sun-synchronous, 450 nm circular orbits that map the earth two times each day at visual and infra-red frequencies. The satellites constantly transmit the imagery information they gather in real time and store up to three orbits of data on tape recorders. The resolution is 1800 feet at both visual and infra-red.

[REDACTED] The ground based elements comprise large receiving stations at Fairchild and Loring AFB's which receive the tape recorder dumps and about fifty terminals on trailers and aircraft carriers which receive only the real time data transmitted to them while the satellites are in view of a particular ground terminal.

[REDACTED] The satellites and large receiving stations are vulnerable and can be destroyed quickly. The number of mobile terminals makes is likely that

[REDACTED]

some would survive; these will be available to receive the data from replacement weather satellites.

[REDACTED] The concept for a replacement weather satellite is a 600 lb. spacecraft that uses a scanning radiometer to acquire visual and infra-red data which are immediately transmitted to earth. Resolution is 4.0 nm at both visual and infra-red. The satellite is autonomous with an on-board space navigation system to obtain position and attitude information without dependence on ground tracking stations. The satellite could be maintained on alert on a MM-III booster in a silo; alternatively two satellites could be launched by a MX.

[REDACTED] After launch the satellite is boosted to a low earth parking orbit until an injection motor "kicks" the satellite into a 12 hr. 63<sup>0</sup> or 8 hr. polar orbit. The spacecraft will commence transmitting weather data in 3.6 hours from the launch. Two such satellites will provide coverage of the northern hemisphere every six hours. The operational linescan radiometer uses a six-inch Cassegrain optical train for both frequencies.

[REDACTED] There are some changes required in the trailer and aircraft carrier terminals to receive the global (as opposed to local data). The changes are incorporated on two printed circuit boards.

[REDACTED] Launch of the satellites will be commanded by the ICBM command and control system with the exception that launch authority need not involve NCA.

[REDACTED] Communications Relay (SATCOM)

[REDACTED] Several communications satellite systems are in use for military missions. Replacements for two of those are described here to illustrate the concept.

[REDACTED] The AFSATCOM system provides communications service between the NCA and the SIOP force such as bombers, tankers and ICBM launch centers. The system consists of ground and space segments. The ground based elements include large fixed terminals, terminals at ICBM launch control centers, and

[REDACTED]

terminals on B-52, KC-135, EC-135s, and E-4Bs. The mobile terminals will survive if the airplanes survive. The fixed terminals will be destroyed if targeted.

[REDACTED] The space segment consists of 3 satellites in 12 hr. orbits (SDS) and 3 satellites in synchronous equatorial orbit (FLTSAT). There are additionally Single Channel Transponders (SCT), on DSCS III satellites. The space assets are vulnerable as are all resident satellites. Replacement satellites will need to be compatible with the existing ground terminals which survive. The major difference between the replacement satellites and the resident satellites is that the replacements are autonomous and carry only a few (up to 4) narrowband channels compared to the twelve channels on the resident satellites.

[REDACTED] The replacement satellites could be stationed in an ICBM basing system. One option would be to put a single satellite on MM-III as depicted in Figure 5-28. Two such satellites could be launched by M-X. The satellites would be launched into a low earth orbit as depicted in Figure 5-29 and kicked into a twelve hour elliptical orbit. This orbit provides coverage for the northern hemisphere above 30°N and duplicates the Satellite Data System (SDS) orbit. The time from launch to satellite operation is 3.6 hours. Life of the satellite is limited only by reliability of the system; there is no redundancy.

[REDACTED] The AFSATCOM mission package will provide up to four narrowband (5000 Hz/75 bps) record communication channels at UHF (225-400 MHz). Alternatively the satellite could carry the DSCS III SCT which allows two way UHF and a SHF uplink from large (Type 78) DSCS terminals if they are available. Launch of the satellites could be accomplished by the existing ICBM launch control system.

[REDACTED] The normal wide-band communications system used for CINCPAC is the Defense Satellite Communications System (DSCS). The system, in addition to data services, provides secure voice services between CINCEUR, CINCPAC and CONUS. The space segment consists of four large wideband satellites in synchronous equatorial orbit. The satellites have both earth coverage and

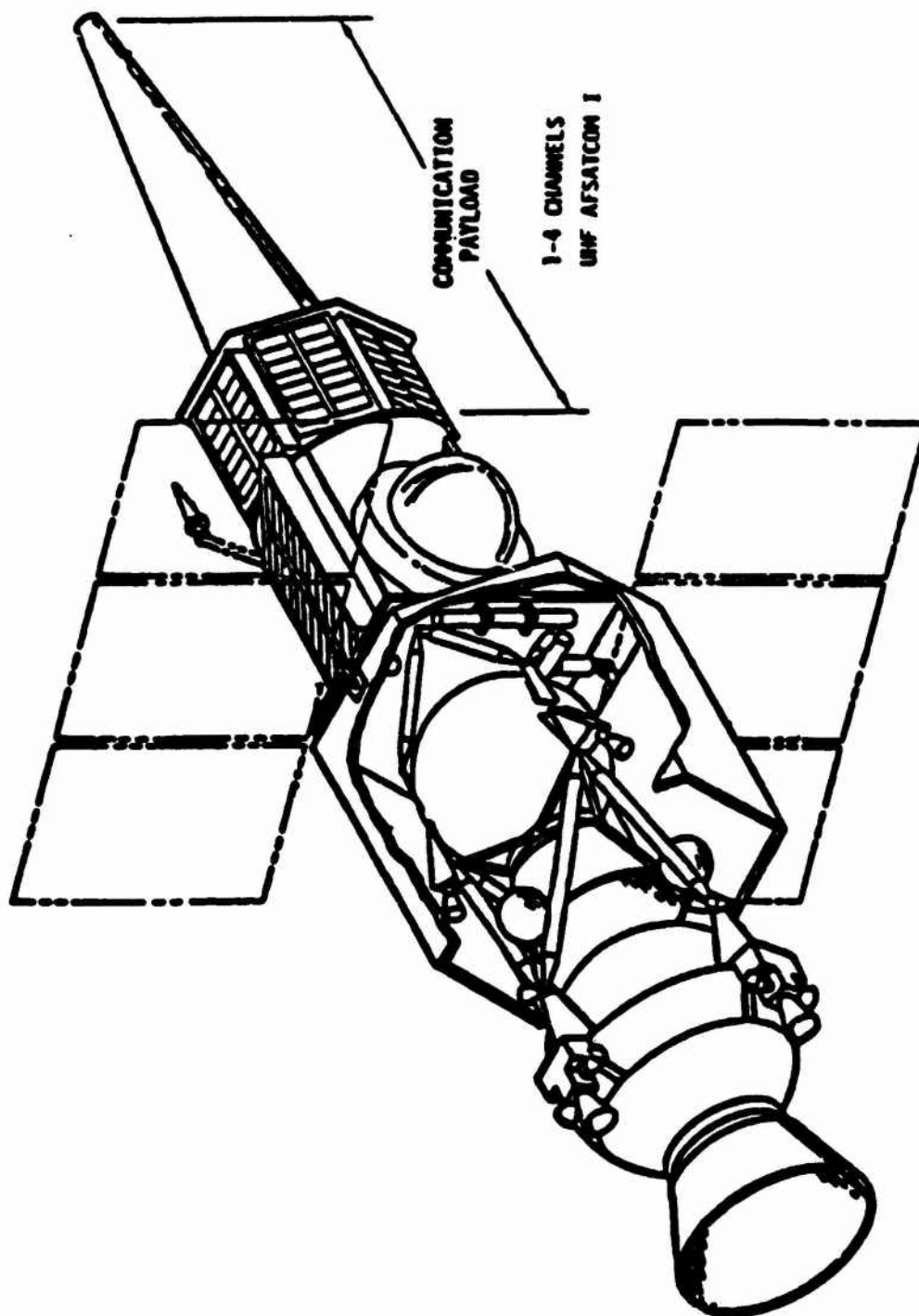


Figure 5-28. Replacement AFSAT (compatible with NI-III).

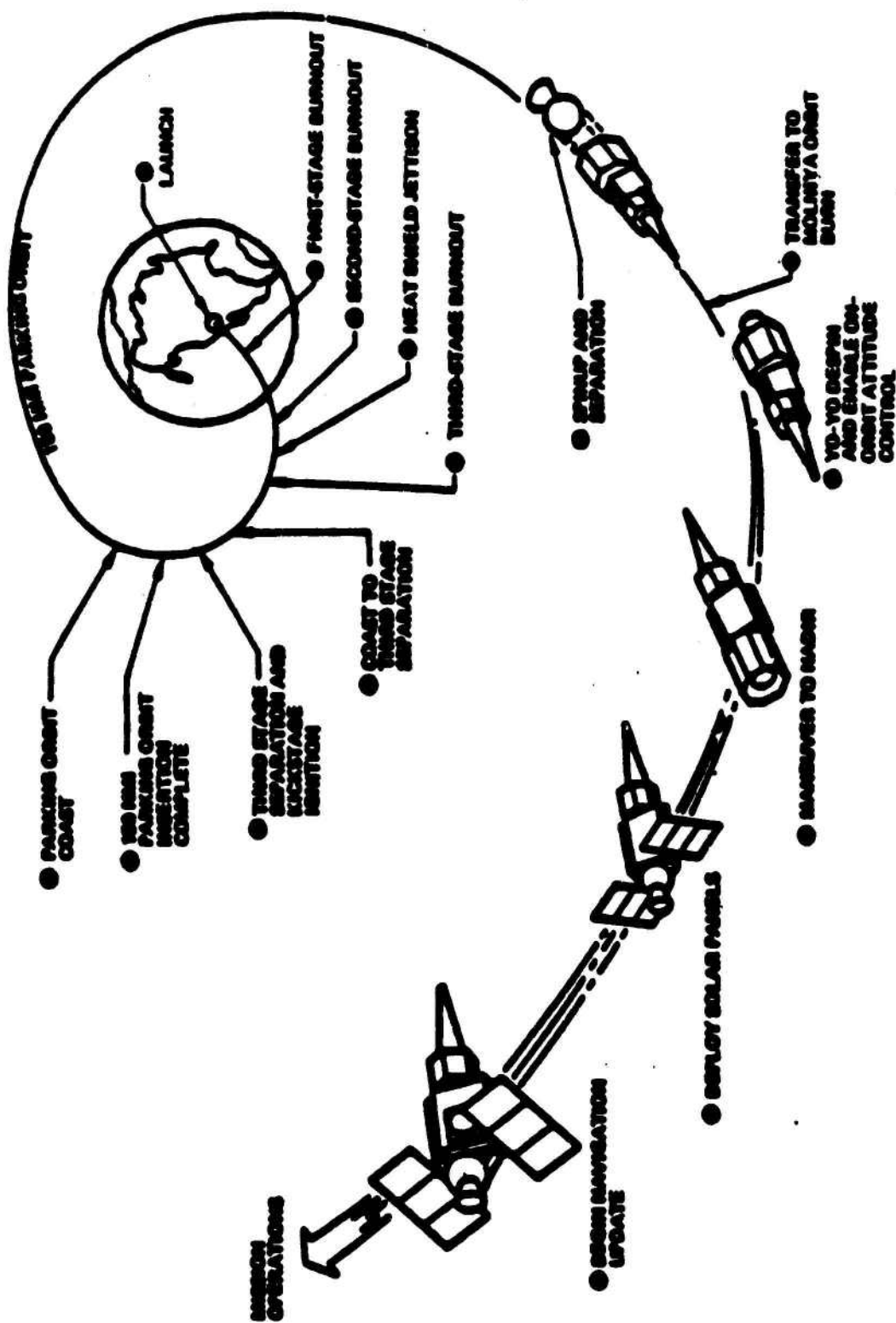


Figure 5-29. Launch event sequence.

[REDACTED]

spot beam antennas. The ground segment includes very large (Type 78) terminals down to one man transportable terminals, and airborne terminals on E-4B aircraft. The transportable and aircraft mounted terminals would have a better chance of survival than the large terminals which may be easily targeted. Frequently the large terminals are located at sites that are targets for other reasons. It is necessary to make the replacement satellite compatible with the ground terminals which are likely to survive, which means that frequency modulation data rate, etc., must be matched.

[REDACTED] The coverage required for secure communication between CINCs is shown in Figure 5-30. The satellite would operate at 9-11 GHz and would be capable of linking with a three foot dish such as that used on the E-4B. The data rate is 16 Kbps which can be used any way one wishes; i.e., voice or data or combination of the two. Six full duplex voice channels using linear predictive coding, LPC, can be had with good voice fidelity; the LPC channel requires 2400 bps. Using a multiplexing mode, any number of voice channels up to six can be provided with the rest of the capacity used for data.

[REDACTED] Two such satellites can provide continuous coverage of the Northern Hemisphere above 30°N, which is the area of interest. Satellite and launcher configurations would be as described above for AFSAT replacement.

[REDACTED] Missile Attack Warning

[REDACTED] Missile strike warning is required for:

- 1) Determination of the country of origin of missile launches,
- 2) Launch of strategic forces response,
- 3) Protective reaction.

[REDACTED] TAWSAT (E) is a candidate system concept for replacement of missile warning sensor. The ICBM sites in the Soviet Union are located in areas where

*Page 226 is deleted.*



[REDACTED]

they can be seen from Molniya\* or synchronous equatorial orbits with a small field of view sensor. The sensor is a mechanically scanned line array consisting of 1500 lead sulfide detectors. The technology is that of the existing system which has been operational for ten years. Risks of development are non-existent but the hardware is relatively expensive. The onboard processing load is about 100 Kbps to derive a 65 Kbps downlink.

[REDACTED] An alternative payload that uses higher technology would be a staring mosaic sensor - also with a narrow field of view. The mosaic has the advantage that it reduces the clutter limit over that of a mechanically scanned sensor and promises to be lighter. The mosaic has the disadvantage that it has not been tested in a space environment and hence involves some technical risk.

[REDACTED] Two narrow field of view satellites could continuously observe the Soviet Union ICBM sites and be in continuous contact with an AABNCP over the CONUS. The downlink power is designed to be compatible with antenna that could be carried by aircraft. One such satellite could be launched by a MM-III booster (with upper stages) or two satellites could be launched by an MX. Basing could be any mode that will not constrain the length of the booster since upper stages are required. The survivability of launcher and satellite elements must be assumed so that attack warning can be restored.

#### Photo Reconnaissance

[REDACTED] There are many uses of photographic reconnaissance in the protracted war situation. If a counterstrike has been executed against military targets, photography can aid in verifying damage to targets. Some of these targets can be reconstituted in short time spans. Photography can determine the state of reconstitution so the targets could be struck again if necessary. Photography can determine the deployment of projection forces by noting the aircraft at airfields and vehicle counts at transportation choke points such as mountain passes and highway junctions.

\* Molniya: A Russian communication satellite launched into an elliptical orbit with a 63° inclination and a 21,000 nm apogee and 200 nm perigee; the orbit provides excellent coverage of the northern hemisphere including the polar region.

[REDACTED]

[REDACTED] Rapid deployment photo reconnaissance satellites can be launched for one or two orbits and then re-enter over the CONUS where the data are recovered. The film or magnetic tape requires interpretation, and enduring capability for that must be provided since the locations where this is routinely done will have been destroyed in the initial attack. A mobile or transportable interpretation facility for that purpose would have to include light tables, microstereoscopes, variscans and spectrum analyzers as well as trained personnel.

[REDACTED] Photo I (MM-III Launcher)

[REDACTED] Once around reconnaissance using a booster of the MM-III class can be accomplished by using a reentry vehicle to de-orbit the camera and film at a predetermined spot. Photo-interpretation would have to be done on the ground, which is a separate but very real problem. A baseline 24" catadioptric system is estimated to give (from low earth orbit) a ground resolution of 7' - 8'. Figure 5-31 illustrates the level of detail that could be expected. One may differentiate between large transport aircraft and small transport aircraft but cannot discern a fighter (in this case an F-86 chase plane). One can further get a reasonable count of vehicles parked in parking lots on or off highways at this resolution.

[REDACTED] This satellite may make many orbits, for which it is necessary to carry a space navigation system in order to 1) photograph the proper area, and 2) to de-orbit at the proper spot - probably over CONUS.

[REDACTED] The reentry vehicle would be a low beta device, probably made of Oblique Tape-Wound Refractile (OTWR); a parachute would be deployed at about 50,000 feet and beacons would be activated to guide the recovery operations. Since recovery will be on land it can be made at night which is an improvement over the existing film satellites whose recovery is limited to daylight hours. The total timeline from launch to reentry could be as low as 100 minutes.

[REDACTED] The vehicle could be carried on a MM-III booster with an already designed fourth stage that weighs about 1400 lbs. Weight in orbit is about 1200 lbs. An interesting feature of the system is that a MM-III weapon can be

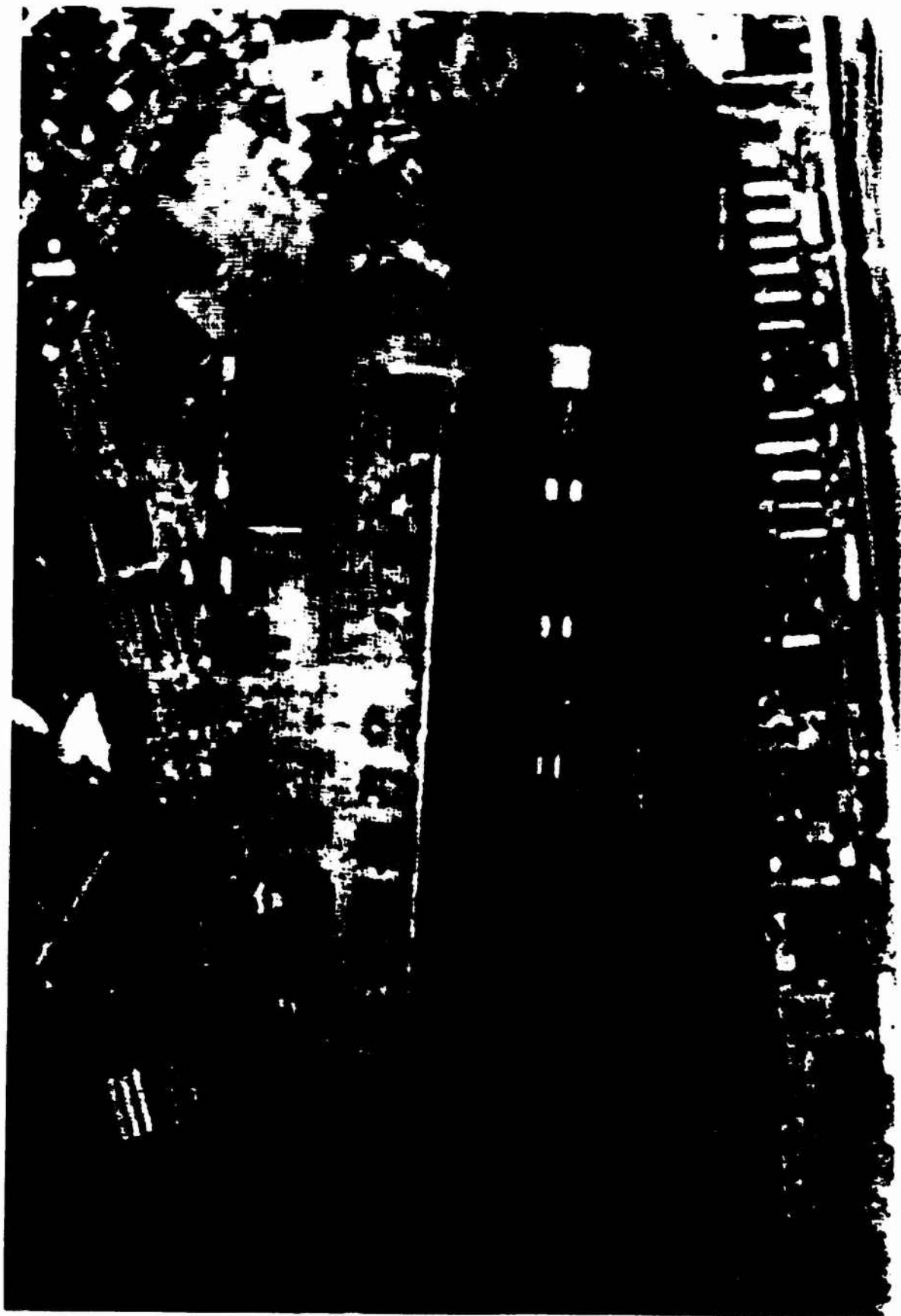


Figure 5-31 Seven Foot Scan Line Resolution

[REDACTED]

converted into a surveillance system in less than 24 hours. This presupposes that the upper stage and spacecraft are available. The procedure could be to transport the upper stage/spacecraft to the silo in the existing payload transporter, open the lid, remove the R/S and RBPS and emplace the surveillance assembly.

[REDACTED] Photo II (MX Launcher)

[REDACTED] The increased payload of the MX will allow a satellite substantially larger than MM-III. Again it requires a fourth stage on top of the three stages of MX. The spacecraft would be an autonomous satellite capable of ejecting and de-orbiting multiple data cassettes at predetermined locations. There would be no requirement to de-orbit the spent spacecraft, saving the weight of a retro motor.

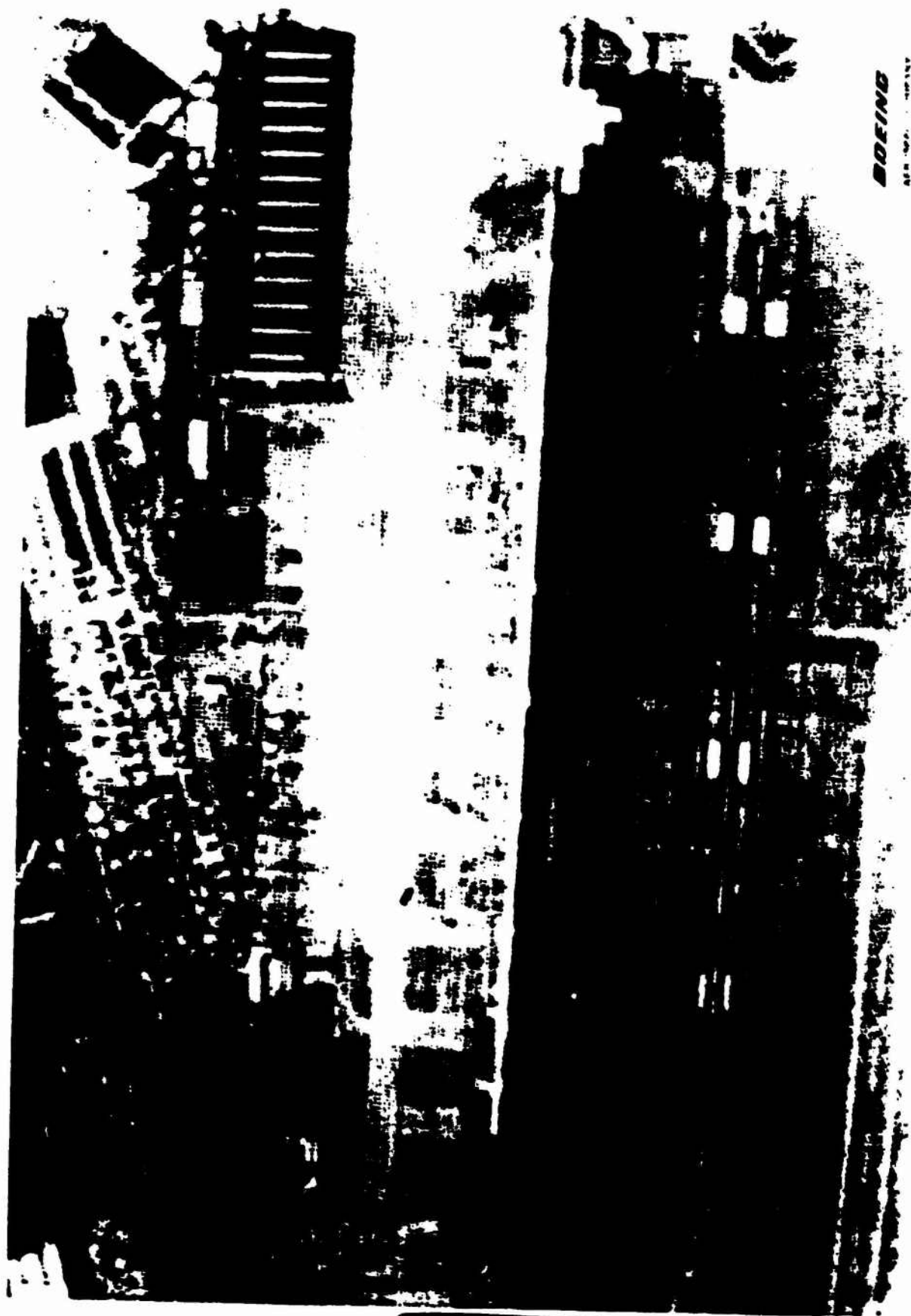
[REDACTED] The performance of such a system is illustrated by Figure 5-32. A ground resolution of 4-5 feet is expected. Damage to, and reconstruction of, critical targets could easily be monitored with such a system.

[REDACTED] The MX space booster is necessarily longer than the weapon booster because of the fourth stage; this presents problems in basing. If mobile basing is used, a longer transport vehicle would be necessary or the kickstage and satellite could be mated in the exposed position.

[REDACTED] Fixed basing (silos) would accommodate such a kickstage and satellite readily. The total length of the Photo II vehicle with satellite, kickstage and MX would be approximately eighty feet. The MM silos are eighty-seven feet deep. The weapon front end and the surveillance satellite front end are interchangeable. Launch of the system would be accomplished by the ICBM command and control system, the MEECN.

5-4.2.2 [REDACTED] Booster Requirements for Satellite Replacement

[REDACTED] A ballistic missile booster with the capability of delivering one or more warheads a distance of 6000 nautical miles achieves a peak velocity of about 24,000 fps. To place a platform as those described above into a Molniya



BOEING  
AERONAUTICAL DIVISION

Figure 5-32 Four to Five Foot Scan Line Resolution

[REDACTED]

orbit requires an injection velocity of about 40,000 fps. This requires the addition of two stages to the basic Minuteman or MX booster. A fourth stage, achieving 30,000 fps would insert the payload into a parking orbit. From there it would be kicked into a specific elliptical orbit by a fifth stage achieving the necessary injection velocity. To place a similar payload into a synchronous equatorial orbit requires a sixth stage to circularize the orbit and effect the plane change necessary. The latter maneuver makes this an inefficient but possible solution to satellite replacement. The staging sequence to achieve the Molniya orbit is shown in Figure 5-29. Adaptation of ICBM boosters for launch of replacement satellites requires lengthening the booster. Figure 5-33 illustrates this for conversion of a Minuteman III booster to satellite configuration. The modest length increase is made possible by removing of the NS-20 guidance section and including the necessary inertial instruments into the satellite package.

[REDACTED] Figure 5-34 summarizes the results of an investigation to determine the boosters that may be considered. (A totally new booster was considered too expensive.) Only a few are really suitable. Militarized boosters are hardened against EMP; some boosters are in production or in surplus supply; some boosters have insufficient payload to orbit. The choice of booster, to some extent, is dependent upon the basing system and not on the booster characteristics.

[REDACTED] The most suitable boosters are:

- 1) C-4, which is in production, hardened against EMP, radiation and X-rays.
- 2) MM-III, about 140 MM-III boosters are surplus, hardened against EMP, radiation and X-rays.
- 3) MX, which is hardened and which may be in production for the next decade.

#### 5-4.2.3 [REDACTED] Launcher Requirements for Replacement Satellites

[REDACTED] A major aspect of the replacement of space platforms for surveillance and relay functions is the timing of their availability. It affects requirements on the launcher and launch facilities. For any space platforms

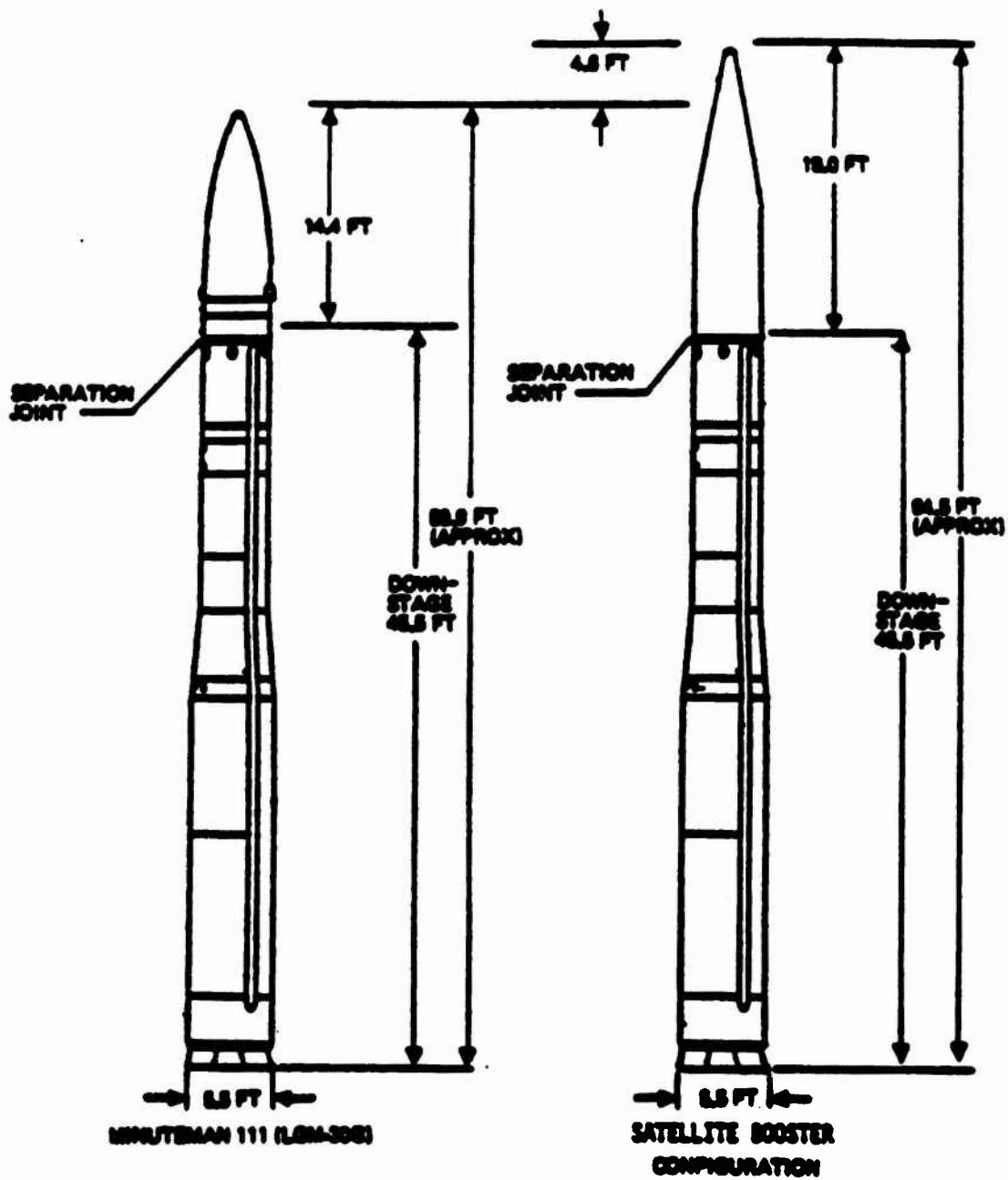


Figure 5-33. Booster configuration comparison.

ORBIT	SATELLITE WEIGHT IN ORBIT, LB.							
	TITAN II	M-X	D6	MMH	C4	C3	SCOUT	PERSHING II
LOW ALTITUDE	2700	—	—	1230	—	—	300	7
8 HR. POLAR (OR 12 HR. EQU. ELLIPTIC)	1000	1000	1000	630	600	200	300	—
24 HR. SYNCHRONOUS	1200	400	300	200	—	—	—	—

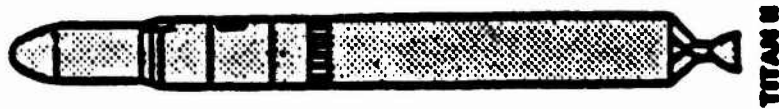


Figure 5-34. Booster capability.



[REDACTED]

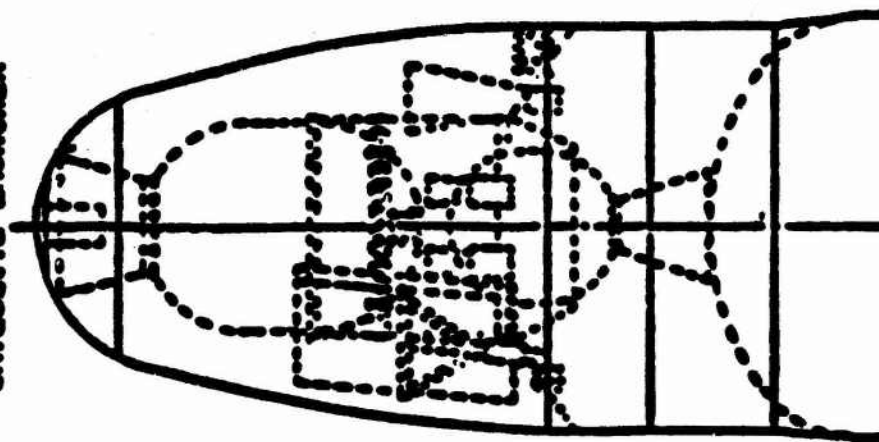
required during or immediately after the nuclear exchange survivable launchers would be needed with launch control by ground or airborne control facilities. Reconnaissance and surveillance missions during the protracted war, as well as communication relays in support of force projection and support of allies will be launched days, weeks or even months after the initial exchange. Launches for these types of missions can take advantage of any suitable facilities which have survived or have been reconstructed. The major concern is for survival of boosters, space vehicles, and launch control equipment and personnel.

[REDACTED] The results of investigations into the timing requirements for replacement satellite launches are summarized in Table 5-15. Approximately four hours are required for the satellite launch and orbit insertion phases. This factor must be considered in scheduling launches. There are basically three time periods during which replacement launches may be required. The first two, just before and during the counterforce exchange, require rapid deployment capability. If central exchanges can be assumed to take out the tracking network (these networks track ballistic missiles as well as satellites and are extremely fragile) space is a sanctuary. This suggests that rapid deployment satellites should be launched before central exchange weapon arrival. In this case, survivability for the launcher would not be a requirement. If the assumption is made that warning will be available, then there is no need for special hardening of launch facilities and boosters, providing they are readily available and protected from sabotage. However, if reliable warning cannot be expected then it will be necessary to provide survivable launch facilities for those satellites which are to function during and immediately following the nuclear exchange, e.g. NUDET detection, attack warning, etc. The use of hardened silos for a substantial number of satellite launchers may cause difficulties because of SALT limitations on launchers. TRIDENT tubes may be available but it is not clear that such submarines could launch satellites when they were needed because the launch might reveal the position of the boat. A more serious drawback to submarine basing is the volumetric limit of the launch tube illustrated in Figure 5-35. The satellite launcher involves four stages when five are ideally needed for a twelve hour elliptical orbit.

Table 5-15. Launch timing requirements.

MISSION	FUNCTION	LAUNCH TIME	PREFERRED BASING/BOOSTER
ICBM COMMUNICATIONS	STOP/REPORT BACK		SILO/MM III
BOMBER COMMUNICATIONS	STOP/REPORT BACK		SILO/MM III
SSBN COMMUNICATIONS	STOP/REPORT BACK		TEL-SHELTER/M-X SSBN/C-4/MESA
CINCPAC	CINCPAC/CINCEUR/MCA/ UNIFIED/SPECIFIED		SILO/MM III
EASTERN NSL WARNING	USSR ICBM LAUNCH- ATTACK ASSESSMENT		SILO/MM III
WESTERN NSL WARNING	USSR SLBM LAUNCH- ATTACK ASSESSMENT		SILO/M-X
EASTERN NUDET	STRIKE ASSESSMENT		SILO/MM III
WESTERN NUDET	DAMAGE ASSESSMENT		SILO/MM III
NAVIGATION	POSITION INF. TACTICAL FORCES		M-X/SILO
PHOTO I & II	STRIKE ASSESSMENT		MESA

SATELLITE LAUNCHER



MISSILE

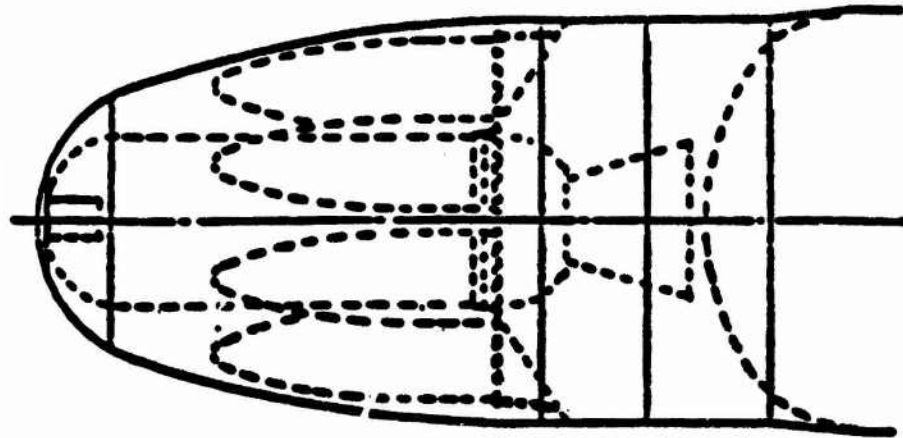


Figure 5-35. C-4 volume and length constraints.

[REDACTED]

Consideration of the mobile MX basing scheme is subject to the same limitation because the transporter erector launcher (TEL) is sized to the length of the missile and an increase in length to accept additional stages would cause an increase in length of TEL, the mobile surveillance shield and the shelters. If MX were to be launched from MM silos, additional length could be accommodated. There are test launchers that could be used for rapid deployment satellites at AFETR and AFWTR. Figure 5-36 illustrates the WTR launcher locations. Note that test launchers are refurbishable whereas operational launchers are not.

Launch of replacement satellites during protracted war (the third time period) requires the enduring survival of satellites, boosters, and launch control equipment. In addition, of course, launch facilities must be available. The deep based MESA concept described in Section 5-2.2 potentially offers the capability to protect and launch satellites for a period of up to a year. While one would not build MESA just for launching satellites, the MESA constructed for FSRF (future secure reserve force of ICBM's) could accommodate space launches. Some modification is necessary because the MX space booster is eighty feet long, ten feet longer than the weapon.

There are at least four ways of implementing satellite launch from MESA.

- 1) Full length launchers for assembled boosters and space vehicles. This case would extend the launch tube and the vehicle by ten feet. There would be no capability to enter the launch tube for any purpose. Lengthening the transporter would impact the tunnel system design in terms of diameter and turning radii.
- 2) Full length launcher with adapter collar on the booster. This differs from 1) in that it allows the satellite payload to be removed and replaced in the tunnels. Thus relatively few boosters can support several types of satellites. It requires handling equipment (overhead hoist and slings), as well as trained technicians, to change payloads.

*Page 239 is deleted.*

- [REDACTED]
- 3) Full length launcher with long adapter collar. This differs from 2) in that the entire spacecraft can be exchanged.
  - 4) Full length launcher with extra-long adapter collar. This differs from 3) in that a space booster and weapon booster can be launched from the same vehicle. Interchangeable front ends (weapons or satellites) provide a great deal of flexibility. This flexibility requires special transportation and handling equipment and trained maintenance personnel.
  - 5) Weapon Size Launcher. This concept features a separate transport vehicle that emplaces the upper stages and the satellite just prior to launch. (See Figure 5-37). This concept is the most time consuming and people intensive of all. The total weight of booster stage/satellite is on the order of 10,000 lb. It does allow weapon/spacecraft interchangeability and does not require tunnel modifications.

#### 5-4.2.4 [REDACTED] Replacement Satellite

[REDACTED] Regardless of the booster or the launch system the spacecraft, for use in a protracted nuclear war, must be different than those in use today. Today's satellites depend upon the AFSCF for control. The AFSCF is a very fragile system and cannot be depended upon to function throughout a protracted situation. An autonomous satellite can guide itself to orbit, station-keep, perform attitude control and doppler correction. The heart of the autonomous system is the self-contained space navigation system; there are several alternatives from mechanically pointed telescopes to electrically scanned CCDs (Charge Coupled Devices). All potentially will work with different degrees of accuracy. No existing satellite has any appreciable degree of autonomy but those for use in a protracted war must be completely autonomous.

[REDACTED] In a protracted nuclear war, the large fixed mission data receiving stations cannot be depended upon to survive. Authority, wherever it exists, will probably have access to a small antenna and processing capability. This

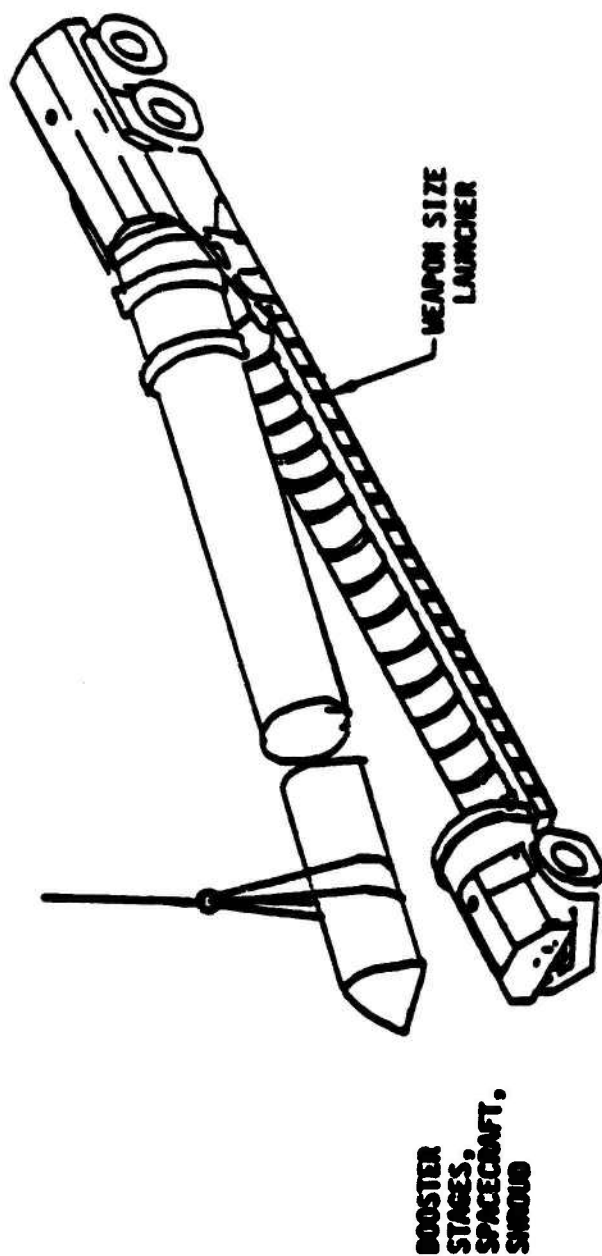


Figure 5-37. Launcher-spacecraft mating.

might be airplane-operable, air transportable, ground mobile or proliferated. The downlink for mission data and communication must have sufficient power to close the link with a small aperture antenna, nominally a 3' dish or equivalent. This differs considerably from some current systems which use 40 and 60 foot dish antennas to receive mission data.

Although a spinning satellite is not desired because some, if not all, of the space navigation sensors will not accommodate spin. It might be feasible to use a despin platform for the space navigation system but this introduces more complexity than the stabilized spacecraft.

A generic autonomous satellite schematic is shown in Figure 5-38. The orbit insertion process from first stage ignition on is handled by the inertial system (IMU, Computer and Clock). When orbit has been achieved, the space navigation package takes fixes to improve the knowledge of the orbit, starting with the nominal orbit in the memory and operating a filter for update with each fix. The space navigation system is required because a pure inertial system will continue to drift in both position and reference unless updated.

The spacecraft uses the navigation information to correct the orbit with the spacecraft propulsion system and to report the geographical position of missile launch and NUDETS and launch azimuths. The spacecraft structure must be stable when the satellite is subjected to sun exposure in various positions to prevent misalignment between mission telescopes and the space navigation system. The current system uses ground references which are vulnerable. The Boeing Company has built and tested a thermally stable graphite structure in the space chamber. The results show a thermal warp much less than the accuracy of the various sensor assemblies.

Figure 5-39 illustrates a block diagram of a spacecraft control system design for use with a MM-III booster. The objective of this configuration was to achieve a system that could be rapidly deployed and most of this hardware exists. For example:

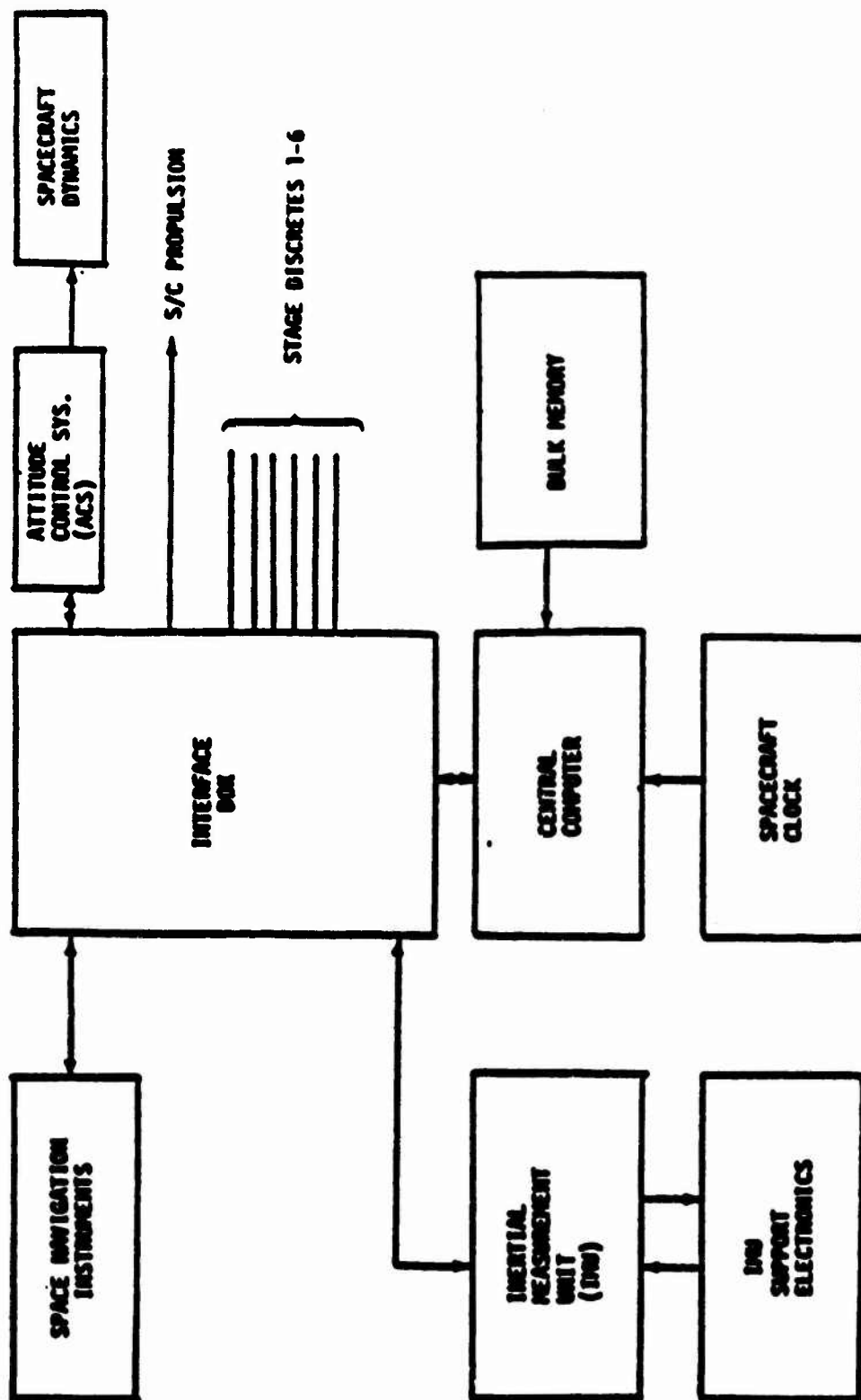


Figure 5-38. Generic autonomous spacecraft schematic.





**Figure 5-39. SLS guidance, navigation, and control block diagram.**

[REDACTED]

The space navigation unit is the Martin Space Sextant which is under contract and which will fly soon.

The IMU is the Singer Small Hardened Inertial Platform (SHIP) which has been delivered to ABRES.

The processor is the CDC 469R<sup>2</sup> which is flying on HEAO as an attitude control computer.

The clock is flying on GPS.

The altitude control components are from DMSP Block 5D and Boeing S<sup>3</sup> satellites.

The downstage interface is an existing MM-III P-92 control and discrete unit.

The only development required for this system is the interface box and the software.

#### 5-4.2.5 [REDACTED] Summary

[REDACTED] Replenishment satellites can be used in a protracted war for a variety of functions; they must be autonomous spacecraft without dependence on ground control. For some applications, the satellites need to be launched before the central exchange so they will be on station to observe missile launches, NUDET and perform transattack communications. The basing for launchers for these missions does not need to be survivable as a result. "Launch on strategic indicators" - "launch on warning" requires that launcher be on alert and have quick reaction time.

[REDACTED] Survivable basing seems to be advisable for some missions such as reconnaissance and replacement of satellites which fail. The requirement for additional stages required for satellite velocities result in longer boosters which cannot easily be accommodated in either submarines or in MX shelters. These space boosters could be accommodated by a system such as MESA.

In the development of military missions (Section 4) the support of allies was considered of definite importance in the conflict resolution. It is probable that the primary function will be to resupply the NATO and other allied forces with equipment, consumables, and information. In addition, specific military actions may be conducted in support of allies. Of particular interest will be attacks by U.S. (strategic) forces on assembled Soviet Union combined arms forces which are either mounting direct attacks on allied positions or in the process of preparing for force projection.

#### 5-5.1 Long Range Attack on Combined Arms Forces

A most effective military support mission to be offered to allies during the protracted war will be the use of U.S. strategic weapons in attacks on Soviet Union combined forces either as they are forming for attacks or preparing for movement to theaters. The ability for the U.S. to use its retained strategic forces in this manner requires a significant C<sup>3</sup>I capability. Monitoring of the movements of combined arms forces is absolutely essential (see Section 5-4.2 for conceptual ideas). This requires surveillance and reconnaissance capabilities, information exchange with allies, and information evaluation. Furthermore, it needs to have available the ability to assess the status of the remaining U.S. strategic forces, especially their readiness to act, since the combined arms forces targets are probably limited in duration, i.e., they will be in some form of transit, and will be available probably for periods of hours at the most.

In Section 5-2 the subject of enduring strategic strike forces was discussed. Two primary concepts appear to be suitable to address the long range attack on relatively time-urgent targets. Bombers which have survived and have airfield, fuel, crews and weapons available, can perform such attacks effectively. The endurance of ICBM's is assumed to be very limited for currently deployed systems. A new concept of deep based ICBM's as a future secure reserve force is described in Section 5-2.2. Such a system can provide the capability to attack combined arms forces over very long ranges. In

[REDACTED]

addition there may, of course, be submarine based missiles which can be employed for this task.

[REDACTED] The development of specific mission plans has not been carried out in this investigation. It remains to be done. However, if strategic bombers or missiles are retained during the protracted war period, they can effectively attack assemblies of combined arms forces.

The extreme vulnerability of the major portion of the U.S. military logistics systems has been discussed in the section on the protracted war environment (Section 3-3). It rises primarily out of the concentration of facilities related to logistics functions and to the automation of the logistics system through centralized computers. The potential loss of the data base, software, experienced personnel, and storage and transport facilities can be avoided by some changes in operational plans. Two conceptual ideas are presented for consideration and further development.

#### 5-6.1 Concept of Reserve Unit Base Reconstruction Teams

In Section 3-3.1, the effectiveness of a Soviet attack limited to military objectives was discussed. The points were made that destruction of the central buildings at all places attacked was total; that most personnel - especially key leadership, administrative, and logistical personnel - were casualties; that surprisingly large numbers of people could survive; that outlying areas could still be made usable; and that respectable quantities of materiel were reusable.

From the perspective of a protracted war, there are vital things to be recovered at each devastated base. The trick is to have and to manage a national effort to get, redistribute, and use it.

The nation has long had a civil defense structure of sorts under a variety of administrations and names. That program has some skills, knowledge, and capability to perform this base reutilization task, but the focus is wrong for it and, if much damage in civilian communities occurs, the organization will be saturated taking care of that problem.

We suggest that the Reserve Components of the Armed Forces be tasked with the mission to organize and manage the base reutilization effort. Such an effort could be as follows:

- [REDACTED]
- For each sizeable military installation, a reutilization team should be formed in the Reserves or the National Guard. The team would be tailored for the functions and size of the base it is designed for; it would train for that installation. Teams would be equipped organically with gear that could not be obtained locally, e.g. special radios, radiation detectors and protective gear, or programmable pocket calculators with special programs that could be plugged in. Pre-arrangements should be made for obtaining support with bulldozers, cranes, bucket loaders, forklifts, etc., through the U.S. Army Corps of Engineer districts which now obtain that sort of assistance from the civilian contractor world to cope with major disasters, e.g. the northeast blizzards in '77 and '78 or the aftermath of the Mount St. Helens eruption.
  - Where clusters of many military installations exist in a small area, e.g. Norfolk, San Diego, San Francisco, there should be a local control group for all the teams in that area.
  - The primary mission of these teams would be to provide immediately reusable facilities and materiel. They should perform damage control just extensive enough to assess what is usable or can be readily repaired. Having inventoried what is there (to include survivors), the team should report its findings, through surviving communications media or over its special radio, through its chain of command.
  - The team leader is in command of the installation and its survivors until such time as directed otherwise. He will use his team and those survivors who can work plus the borrowed heavy equipment to establish a work camp, organize an equipment/supply area, and start collecting usable things to stock it. He will repair what he can with emphasis on utilities and parts of the base that can be used by activated reserve component units. He will continue to report upward on the installation status at regular intervals.

- [REDACTED]
- Training for these teams would cross many lines: medical, equipment operation and repair, blacksmithing, communications, etc. Their normal home station should be in a small community that is easily accessible to the base, but is far enough away and insignificant enough to not be affected by the prompt effects of a nuclear weapon, i.e., a place where their survival is better assured. Thus the team could train frequently at the base concentrating on learning all about its facilities -especially underground utilities, hard storage areas, supply areas, maintenance facilities, and ranges. They should be exercised frequently to ensure that they know their base thoroughly and can wisely select the most remunerative areas in which to concentrate their efforts.
  - The size and composition of each team would be tailored to the base it would take over. Size being a function of the size of expected salvage operation rather than such criteria as the number of people normally working at the installation or the total acreage of the base.

[REDACTED] A problem of concern with this proposal is that of recruitment/retention in the Reserve Components. Recruitment never will be easy, but manning these teams should be as easy as it ever gets. Assuming they are not skimped on equipment or training money, they will become elite organizations, appealing to a large number of people. The appeal would derive from the variety and practical nature of the training and the every-day-world applications of the skills learned; both on the civilian job and in response to natural disasters.

#### 5-6.2 [REDACTED] Computer/Data Base Protection

[REDACTED] In addition to destruction of military forces and their operating bases, the Soviet attack cut out most of the military logistics systems. Buildings are gone and significant amounts of tools and material will have been destroyed by immediate weapon effects and secondary fires. However, the material frequently is packaged to withstand rough treatment and much of the

[REDACTED]

machinery is inherently hard to destroy. The reutilization teams can do much to salvage these precious resources.

[REDACTED] The vital asset which is difficult, if not impossible, to replace is the logistics management system. The current Military Standard Logistics Systems (MSLS) places its prime emphasis on attaining: ... "a greater degree of simplification, standardization and automation in logistics functional areas" (Ref. 18). Much of that aim addresses economies of the logistics system. This is achieved in part by centralizing supply storage and maintenance facilities, e.g. the Red River Army Depot which supports over 50% of the Active Army divisions (Ref. 19), and by computerizing the data system. The vulnerability of the storage areas is obvious. It can best be overcome by dispersal of the assets. First of all, economics has dictated extreme functional centralization and almost total reliance on computers to do business. There is essentially no manual backup capability. Those experts who might be able to function without the computers and their data bases (which were destroyed) are the most likely ones to be casualties from the attack.

[REDACTED] The automation of data systems is quite effective in peacetime operations. During the type of attack described in Section 3-3 most of the MSLS computer centers and their data systems will be destroyed. This will affect also the trained and experienced personnel. The conceptual idea proposed here to overcome the potential loss of access to any surviving supply stores is to assure compatibility of the MSLS computers and software with commercial automatic data processing systems. In addition, pertinent logistics data and programs need to be stored in survivable locations and frequently updated. In this manner it will be possible during protracted conflict, following an attack on military facilities, to reactivate the MSLS through use of surviving data processing equipment. If appropriate measures are taken to transfer current software and data bases to civilian locations, and if they are not destroyed along with the military facilities, restoration of logistics management could be accomplished.

[REDACTED] If the Soviets attacked U.S. cities as well as the strictly military target system, the difficulty of solving this problem is increased magnificently. We know that priorities of early post-attack effort would not be



[REDACTED]

directed toward protracted war. However, the U.S. must have a strong defense quickly or it will be overtaken by someone. (Mexico?) Thus we must establish a means to recoup our military strength quickly, even after a massive nuclear strike by the Soviets. Restoral of the logistics system is central to that effort and some practical means of coping with the computer/logistics data base destruction is essential. The scope of this problem is so huge that it will require a separate study to produce even general recommendations for a solution.

5-7 [REDACTED] SUMMARY

[REDACTED] A number of conceptual approaches have been described which, if employed, would enhance the U.S. military's protracted war-fighting capability. The concepts presented encompass new systems, e.g. short field bombers, deep based strategic reserve forces, and replaceable, autonomous satellites, and operational concepts like dispersed shelters for military personnel and base reconstitution units.

[REDACTED] The conclusion to be drawn is that there are modifications to current U.S. military operations and facilities which can be implemented with minimal costs to support some of the capability needed for protracted war. Furthermore, it shows that war fighting concepts will have to be developed which respond to the conditions which are expected to prevail during the protracted war. And finally, some costly changes to strategic and C<sup>3</sup>I systems will be necessary if the concept of protracted war as discussed here is considered a serious possibility during the coming years.

[REDACTED]  
SECTION 6  
[REDACTED]

INSIGHTS/FURTHER WORK

6-1      INSIGHTS

This conceptual study has described a probable start of a nuclear war consisting of a massive but inconclusive countermilitary nuclear weapon exchange between the U.S. and U.S.S.R. It has sought to describe the reasons why this war could very probably become protracted and to conceptualize the environment that would likely characterize this protracted war. It then theorized what the principal military missions for U.S. forces would be and examined ways in which the adequacy of present or planned forces for these missions in this environment could be improved. This has led to a number of insights from which we are prompted to draw "conclusions". At the same time we recognize that the material studied is still too conceptual and is based on estimates and assumptions containing too many uncertainties to be classified conclusive. Still, there is a sufficiently large number of common insights running through a sufficiently broad variety of scenarios and assumptions to permit the formulation of generalized comments. In recognition of these uncertainties about an event that has never occurred, we describe our concluding comments as "insights".

6-1.1      Personnel

Throughout all aspects of this study we have repeatedly encountered two commonalities. First, the tremendous need for trained, in-place military personnel with which to prosecute a protracted war, and second, the extremely high level of fatalities and disabling casualties our military personnel are expected to sustain. Further, this fatality and casualty level is relatively little changed even if we have strategic warning in time to make postural changes. It is clear that *provision for survival of military personnel is as important as equipment survival*. Yet across the full spectrum of our armed forces personnel survival from the consequences of nuclear war has received essentially no attention. It probably has the highest cost-effective potential of any of the measures studied for increasing U.S. capability to survive and prosecute a protracted war.

[REDACTED]

6-1.2 Military Logistics

[REDACTED]

6-1.3 Mobilization and Force-Projection Capabilities

U.S. mobilization and force-projection capabilities are highly dependent upon an existing training base and logistical capabilities. As just noted, both the in-being military personnel force, particularly those involved in training and logistics, as well as the logistic and training facilities themselves will probably suffer catastrophic levels of damage. *These military fatalities will severely degrade U.S. mobilization and force-projection capability.* Whereas alternate facilities, including conversion of civilian facilities, might be accomplished on a reasonably timely basis, restoration of the personnel cadres needed for mobilization and training will require a much longer time.

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\*Tailored in the sense that the smallest size weapon in inventory which could accomplish the military objectives was used in order to minimize collateral damage.

[REDACTED]

#### 6-1.4 Nature of Space Warfare

Both the United States and the Soviet Union have placed heavy dependence and are placing increasing dependence on the use of space for command, control, communications and intelligence collection/dissemination. There is also a rapidly expanding commercial use of space. Because of the unique military value of space it will certainly not remain a sanctuary should a conflict between the two superpowers occur. It is itself a potential theater where conflict could originate.

Should conflict occur in space its nature would change markedly during protracted warfare. *With the onset of central nuclear exchanges the nature of space warfare will shift from attacks on assets in space to attacks on ground based support equipment.* These ground based facilities are absolutely essential to the continued functioning of space based systems. They include highly complex one-of-a-kind control facilities and very large and easy to damage antennas, radars and optical systems. These ground based systems are also essential to provide tracking and aiming information to anti-satellite systems. Hence *with the almost immediate destruction of ground-based space facilities in the first phase of a central nuclear exchange, reconstituted space satellites will be relatively free from attack for an extended period after this central exchange.*

However, this invulnerability will not apply to satellites of the types both sides are now using. To avail themselves of the use of space *after central nuclear exchange, new spaced-based systems with requirements and characteristics which are significantly different must be used.* The systems need to be essentially autonomous. They require autonomous navigation, position keeping and housekeeping, onboard computing and relatively high-powered transmitters so that small mobile ground receiving, tracking and control stations can be used with them. These characteristics could be built into space systems beforehand. If done, it would greatly increase their endurance and usefulness in protracted war. It would not protect them against direct attack so that even if this is done a requirement to be able to reconstitute space assets will still exist. There is a strong suggestion that the side capable of reconstituting space assets, particularly for effective reconnaissance, will gain a distinct, possibly decisive, advantage.

[REDACTED]

6-1.5 Factors Tending to Prolong the War

The study suggests there are many reasons why such a conflict would tend to become protracted. In addition to the central assumption that the initial exchange is not decisive there are a number of other considerations. *Many factors which impact both sides—the loss of C<sup>3</sup>I and the attendant capability to assess the effectiveness of the attack; the immobilizing fall-out environment for the first week or two after the central exchange, the need for a deterrent force coupled with the inclination for national leaders to hoard their remaining nuclear assets; and a number of societal and other considerations will all tend to slow down and prolong the period of conflict.*

6-1.6 Military Missions

The military missions required of U.S. forces would not materially change under a protracted war scenario. *However, the degree of difficulty in executing them, the emphasis, timing and operational techniques would change, perhaps drastically. Systems which can perform missions autonomously, particularly with respect to reconnaissance, appear better suited for protracted warfare. Hence bomber systems if designed for survivability and endurance (including their supporting systems and weapons) appear particularly suited to protracted warfare.* [REDACTED]

[REDACTED]

The preliminary findings of this study are that the U.S. forces as currently postured are, for various reasons not prepared to conduct protracted warfare with adequate chance for success. Several factors contribute to the limited capability for protracted war. All of the U.S. military facilities except the missile silos and the ballistic missile submarines are highly concentrated and essentially soft to attacks. And the survivable, hardened systems are not designed to endure for long periods of time, i.e., the duration of a protracted war. These factors are compounded by the lack of organized recovery planning.

A number of tasks are identified here resulting from this initial study which warrant further and more in-depth investigation. They address conceptual ideas which could contribute to enhanced capability of U.S. forces to conduct military operations during a protracted war.

#### 6-2.1 Strategic Weapon Systems

Conceptual designs need to be pursued for strategic aircraft which will be able to operate without the very limited number of large runway airfields required by B-52 aircraft. Operations from short runways or even unprepared fields must be considered. Such conceptual designs must include availability of the essential supporting functions, e.g., crews, fuel, maintenance and repair, and weapon stores (bombs, cruise missiles, etc.).

Similarly, basing concepts for ballistic missiles must be developed further so that the enduring survival of such weapons can be assured. The range of concepts to be investigated should encompass active, autonomous weapon systems and dormant, unmanned weapon and support system storage.

These investigations should utilize the extensive earlier concept developments both for retainable bombers and alternate ICBM basing. The important task will be to identify the concepts which are compatible with the anticipated protracted war requirements and then prevailing conditions.

## 6-2.2 Survival of Conventional Forces

The ability to conduct military functions during protracted conflicts will be a function of speed and extent of recovery of the military forces from an initial nuclear attack. Dispersed storage of critical assets like weapons and equipment, and sheltering of soldiers are considered to be the simplest and least costly approaches. They warrant further conceptual development toward economic and effective solutions.

Another aspect of enhanced survival is the preparedness for entering attacked areas for salvage of materiel and assistance to surviving personnel. Similarly, the survival or reestablishment of logistics systems must be planned for. Initial conceptual ideas for meeting these needs have been described in section 5 above. They must be developed further to the point where the potential effectiveness can be assessed and eventually tested.

## 6-2.3 C<sup>3</sup>I Capabilities (Including Space Based Systems)

The anticipated nuclear attack which would initiate the prolonged war is expected to destroy most of the nodes of the military communication systems, the command centers, and the ground and space based surveillance and warning sensors. Airborne command posts and communication relays are expected to survive the attack but are found to be limited in endurance.

Concepts need to be developed and evaluated for reestablishment of communication nodes, command posts, and sensor systems. Such concepts must take into consideration the environment and conditions expected to exist during the protracted war. Three major categories of system concepts will need to be developed and evaluated. Some will be ground based, some will be airborne using short field type aircraft, and finally, the replacement of space based sensors and relays.

As discussed above, any systems for operation in space must be autonomous since ground based tracking and control facilities will be destroyed initially and their reestablishment prevented. All of the concepts

[REDACTED]

must address also ideas for the survival of key personnel and critical assets through the initial attack and their enduring availability.

#### 6-2.4 Integrated Studies Approach

A number of improvements which can be made to enhance existing systems effectiveness in a protracted war have been discussed. There are many other new systems which could be developed in response to this requirement. The subject is so broad and interwoven that it would be useful to undertake an effort which makes a first attempt at structuring an integrated approach to the postural changes needed for protracted war. Such an effort should consider all aspects of the problem—personnel, weapon systems, supporting systems, logistic base and C<sup>3</sup>I. It should also define the extent, feasibility, priority, cost and timing that are envisioned for these changes. No quick, easy or inexpensive solution will be found. But if a steady and integrated approach is followed over the next decade, the resultant posture will undoubtedly be one which can create sufficient uncertainty in attack outcome that Soviet leaders will be deterred not only from undertaking such an attack but also from threatening to do so.

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[REDACTED]

SECTION 7  
REFERENCES\*

[REDACTED]

(References of Section 1)

- 1 Pravda, December 2, 1972
- 2 Pravda, August 22, 1973
- 3 Gyula Kallai, "Main Force of the Revolutionary Process",  
World Marxist Review, No. 11, November 1972
- 4 Pravda, August 22, 1973
- 5 Pravda, December 22, 1972
- 6 Izvestiia, June 2, 1972
- 7 Komsomol'skaia Pravda, June 4, 1972
- 8 Izvestiia, June 22, 1972
- 9 Pravda, June 15, 1974
- 10 Communist of the Armed Forces, November 1975
- 11 "Why the Soviet Union Thinks It Could Fight and Win Nuclear  
War," Richard Pipes, AF Magazine, Sept. 1977
- 12 New Times, No. 17, April 1980
- 13 Kommunist, No. 3, February 1979

(References of Section 3)

- 1 Douglass, Joseph D. Jr. and Amoretta M. Hoeber, "Soviet  
Strategy for Nuclear War," Hoover Institution Press,  
Stanford, CA, 1979
- 2 Douglass, Joseph D. Jr. and Amoretta M. Hoeber, "Soviet  
Military Thought on Global War [REDACTED]," SPC 79-0431, July 1978  
through March 1979 [REDACTED]
- 3 Russel, J. W. and E. N. York, "Expedient Industrial Protection  
Against Nuclear Attack," The Boeing Company, Seattle, WA, March  
1980.
- 4 Roger R. Bate, Donald D. Mueller, and Jerry E. White, "Fundamentals  
of Astrodynamics," Dover Publications, New York, NY.

\*Note: References are listed by section in which they appear.

[REDACTED]

REFERENCES (Continued)

(References of Section 5)

- 1 Artemov, Warrant Officer N. "At a Field Air Base," Znamenosets (Banner Bearer), No. 8, August 1978, p. 12.
- 2 Vorob'yev, Col. B. "At the Alternate Airfield," Tyl i Snabzhenie Sovetskikh Vooruzhennykh Sil (Rear and Supply of the Soviet Armed Forces) No. 8, August 1977 pp 74-76.
- 3 DIA Handbook AP-550-1-2-69-INT, "Physical Vulnerability Handbook - Nuclear Weapons [REDACTED]," 1 June 1969 [REDACTED]
- 4 Schille, N. E., "Strategic Aircraft Initial/Extended Period Survivability: Basing and Operations [REDACTED]," Boeing Document D180-24832-1, 2 January 1979 [REDACTED]
- 5 DOD Flight Information Publication "Low Altitude Instrument Approach Procedures," 5 October 1978 (9 volumes) [REDACTED]. Two of the 9 volumes covering airfields in the northeast and Texas/New Mexico were used.
- 6 Holze, D. H. and York, E. N., "Industrial Equipment Hardening Study," Boeing Document D180-20450-1, 15 January 1977 [REDACTED]
- 7 Holze, D. H. and York, E. N., "Industrial Equipment Survival/-Recovery Feasibility Program During Event DICE THROW," DNA report no. DNA 4192F, 31 December 1976 [REDACTED]
- 8 Holze, D. H. and York, E. N., "Industrial Equipment Hardening Program-1977 5-ton HE Test Results," Boeing Document D180-22878-1, 12 January 1978 [REDACTED]
- 9 Friddell, K. D., "MISERS BLUFF, Industrial Plant Hardening Experiments and Foam HEST 2," DNA Report POR 7014, 8 June 1979 [REDACTED]
- 10 Funston, N. E., Woo, T. H. and York, E. N., "Expedient Blast Shelters Employing Soil," paper presented at the National Convention of the American Society of Civil Engineers, Pittsburgh, PA, 19 April 1978 [REDACTED]
- 11 "The Future Secure Reserve Force Concept and Deep-Underground Based Missiles," Capt. Joe Sutter, DCS/P&O, USAF, June 1977 [REDACTED]
- 12 [REDACTED] "A Research and Development Plan for Survivable Command Center Technology [REDACTED] (Illusive Answer)," TR115-77, Vol. II "The Plan," May 1977.

[REDACTED]

REFERENCES (Continued)

- 13 [REDACTED] "A Research and Development Plan for Survivable Command Center Technology [REDACTED] (Illusive Answer)," TR115-77, May 1977.
- 14 "Defense Nuclear Agency/Boeing Tunneling Technology Seminar," Proceedings, Contract DNA 001-78-C-0315, Heinz Leistner, Editor, 31 October 1978.
- 15 "Capabilities of Nuclear Weapons," Defense Nuclear Agency Effects Manual No. EM-1, November 1974 [REDACTED]
- 16 Kearny, C. H., et al, "Blast Tests of Expedient Shelters in the MISERS BLUFF Event," Oakridge National Laboratory Report ORNL-5541, January 1980 [REDACTED]
- 17 Kearny, C. H., "Nuclear War Survival Skills" Oakridge National Laboratory Report ORNL-5037, September 1979 [REDACTED]
- 18 DOD Directive 4000.25, "Administration of Military Standard Logistics Systems".
- 19 Army Logistician, "Dynamic Depot," May-June 1979.

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## APPENDIX A

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### SCENARIO AND MODEL (FOREM) FOR STRATEGIC COUNTERFORCE EXCHANGE CALCULATIONS

This appendix provides the assumptions and techniques used for analytical evaluation. Fundamentally, the general rule followed was that each side would do what was best for its national interest, and that it would interpret its national interest in light of its own political ideology, not that of its opponent. Each side's counterforce strike carried out was designed for optimal outcome at the end of a two-sided counterforce exchange.

In the basic counterforce-counterforce scenarios the Soviet first strike had the dual objectives of greatly diminishing U.S. strategic forces and of maximizing, in the Soviets favor, the post-exchange Equivalent Weapon differential between Soviet and U.S. forces. The U.S. response was tailored to obtain the most favorable differential from the U.S. point of view. The counterforce exchanges were analyzed from two conditions of force generation. The no warning or surprise attack scenario assumed the international tensions which preceded the Soviet initial strike were not of a nature that caused an increase in U.S. Strategic Alert Forces over the normal, day-to-day alert forces. The generated alert scenario assumed that the Soviet nuclear strikes were an escalation from a full-scale theater war. Therefore, Strategic Forces were already at maximum alert, and theater reinforcement was in progress. The initiator (USSR) was credited with the capability to sortie a high percentage of his own mobile strategic forces (LRA bombers and SLBMs in port) for survival concurrently with attack initiation. This sortie for survivability did not permit such forces to participate in the surprise attack, but did permit them to be away from their normal bases by the time a U.S. retaliatory strike could occur.

#### Soviet and U.S. Forces

The Soviet forces used are those in being and projected for deployment under a "moderate" threat prediction. They are constrained by the limits

[REDACTED]

of the SALT II proposal\* as it is presently understood. Backfire bombers assigned to Soviet Long Range Aviation (LRA) were included in the Soviet forces used. Soviet ICBM launchers operational at test ranges and extra missiles for post-exchange reload of launchers were not included in the Soviet forces in the calculations.

U.S. forces include those in being and planned for development and deployment under the current FYDP. They also are constrained by the limits of the current SALT II proposal. U.S. forces include FB-111 bombers assigned to the Strategic Air Command (SAC) as well as several thousand cruise missiles planned for deployment by the late 90's. The MX-MPS system is included (IOC 1986 and 200 missiles by 1990).

#### Readiness Conditions and Performance Factors

In the "Generated Alert" case it was assumed that each side had placed all of its nuclear offensive forces, to the extent possible, on alert. Both U.S. and Soviet ballistic missile submarines not in extended overhauls were presumed to be at sea. All generable bomber forces were presumed to be armed and fueled and on strip alert with crews immediately available. All operational ICBM's were assumed to be ready for launch upon receipt of launch commands.

The second case was the "Day-to-Day Alert" posture corresponding to a Soviet surprise attack. For this case, U.S. bombers and ballistic missile submarines were assumed to be on strip alert or at sea in accordance with everyday U.S. practice. Since U.S. ICBM's are all normally maintained on alert there was no change from the generated case for the ICBM force. The Soviet force available for use in the exchange included all ICBM's (which are either maintained at 100% alert or could be covertly generated to that level without U.S. detection), those ballistic missile submarines normally maintained at sea, and any bombers normally maintained on strip alert. However, as discussed earlier, the Soviets, as the initiators, were credited with the

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\*SALT II constraints are exceeded if LRA Backfire is counted.

[REDACTED]

capability to sortie their non-alert mobile forces without alerting the U.S. shortly before or concurrently with attack initiation so that these forces would be away from their normal bases by the time U.S. retaliatory weapons could arrive.

The analysis has accounted for the performance factors of the delivery vehicles and weapons (reliability), the yields and accuracies of the various weapons, the losses due to initial attack (pre-launch survivability) and, where applicable, the penetration of enemy defenses (probability to penetrate). This latter factor is extremely important for bomber/cruise missile systems.

#### Counterforce Targets

Soviet counterforce targets include U.S. ICBM silos, SLBM bases and bomber bases. Attacks on U.S. bomber bases were analyzed using submarine-launched ballistic missiles with those present and future characteristics portrayed in a moderate SALT II-constrained threat. In the generated case, where it would be theoretically possible for large numbers of Soviet submarines to be located a short distance off U.S. coasts, Soviet use of an area barrage attack of U.S. bomber bases was analyzed, but not used, since prudent dispersal of U.S. bombers to counter such a threat would make it to the Soviet disadvantage to expend the large numbers of weapons required to employ this tactic.

The Soviet counterforce attack was considered to include a follow-on attack on U.S. bomber-capable airfields at the appropriate time to destroy any U.S. bombers which had been capable of recovering in the U.S. It was further assumed that similar strikes, using "gray-area" weapons not included in the central strategic systems discussed here, against non-U.S. bases containing recovered U.S. bombers would also be made.

Two Soviet ICBM warheads were used against each U.S. SLBM base facility to destroy SLBM forces not at sea.

[REDACTED]

The Soviet attack on U.S. ICBM's was structured to produce a result optimized for the Soviets, recognizing that the U.S. return strike would be U.S.-optimized. This two-sided optimization was performed by linear programming methodology incorporated into an iterative search process. The quantity optimized was the Equivalent Weapon difference between Soviet and U.S. ICBM forces after the counterforce-counterforce exchange. each side rides out the attack, i.e., neither side uses launch-on-warning or launch-under-attack. The logic used in designing the U.S. response strike presumes no knowledge of how many Soviet missiles of each type have been used and the U.S. response is structured assuming that all Soviet silos contain missiles.

U.S. counterforce targets include Soviet ICBM's, SLBM bases, bomber bases, and appropriate defense suppression targets.

[REDACTED]

APPENDIX B

[REDACTED]

MEASURE OF EFFECTIVENESS UNITS

Equivalent Weapons

Equivalent Weapons (EW) is an index of the destruction potential of an aggregation of weapons used against a large target complex consisting of several different basic target types. It is, in a sense, the number of perfect weapons (kill-probability = 1.0, i.e., one weapon kills one target) which in aggregate would have the same total destruction potential as the weapon aggregation being evaluated.

Generally, EW indexes divide the target sets into three types: soft points, soft areas, and hard point targets. While the mathematics of the computation do not limit how many types of targets may be used, practical intelligence limitations of target-set knowledge do.

In addition, EW indexes consider the kill-probability of each weapon in inventory against the different types of targets in the target set. This kill-probability sums up the basic characteristics of each weapon, i.e. its accuracy (CEP) and its yield (megatonnage). Because this index takes all of these factors into consideration (different weapon types in inventory, characteristics of the various types of targets which make up the target set, and kill-probability of each weapon type against each target type), it is an effective index with which to evaluate nuclear weapon arsenals.

The EW index is, of course, not perfect. For instance, it treats all targets of different types as equal in value and allocates each of the various types of weapons in inventory against the representative percentage of each of the various types of targets in the target set. Thus it does not optimize individual weapon characteristics to selected portions of the target set. Further, since it evaluates target types as a percentage of each target set, it will not, in itself, give a relative measure of the fractions of the target sets surviving on each side. However, these limitations can be overcome through judicious analytical application of the index.



[REDACTED]

For those interested, a mathematical description of EW follows:

The concept of EW (Equivalent Weapons) as an index of aggregated weaponry strength can be illustrated by the following numerical example. Suppose 500 weapons of one particular kind are available for potential use against a set of several thousand targets, of which 45% are type A, 30% are type B, and 25% are type C targets. Each one of the 500 weapons has a kill-probability of 0.5 if used against a type A target, 0.4 if used against a type B target, and 0.2 if used against a type C target.

In a typical set of 100 targets there would be 45 of type A, 30 of type B, and 25 of type C. The average number of weapons required to kill the 45 type A targets is  $45/0.5$  or 90, to kill the 30 type B targets is  $30/0.4 = 75$ , and to kill the 25 type C targets is  $25/0.2 = 125$ . Thus for each 100 targets the average number of weapons required will be

$$45/0.5 + 30/0.4 + 25/0.2 = 90 + 75 + 125 = 290$$

Since this is the requirement for 100 targets killed, the average requirement per target killed is one-hundredth as much or

$$\frac{1}{100} (45/0.5 + 30/0.4 + 25/0.2) = 0.45/0.5 + 0.30/0.4 + 0.25/0.2 = 2.9$$

Thus, in this illustration, 2.9 weapons are required on the average to destroy one target and the total of 500 weapons would therefore be expected to destroy  $500/2.9 = 172$  targets. On the other hand, if perfect weapons (kill-probability 1.0) were available, the destruction of 172 targets would require only 172 weapons. The 500 weapons of the example are equivalent to 172 perfect weapons and, in this sense then, have an equivalent weapon (EW) value of 172, or 0.345 EW per weapon.

[REDACTED]

This computation in condensed form can be written

$$EW = \frac{500}{0.45/0.5 + 0.30/0.4 + 0.25/0.2} = 172$$

Note that the 0.45, 0.30, and 0.25 appearing in this expression are the fractional portions of the target set corresponding to type A, type B, and type C targets; 0.5, 0.4, and 0.2 are the corresponding kill-probabilities. In more general terms the EW value of N weapons of a particular kind is written.

$$EW = \frac{N}{f_a/p_a + f_b/p_b + f_c/p_c}$$

wherein the  $f_a$ ,  $f_b$ ,  $f_c$  are the target complex fractional parts corresponding to target types A, B, C and the  $p_a$ ,  $p_b$ ,  $p_c$  are the corresponding kill-probabilities.

If weapons of more than one type are present in the force, the same formula is used for each weapon type and the results are summed. Note that the  $f_a$ ,  $f_b$ , and  $f_c$  would remain unchanged but that  $p_a$ ,  $p_b$ , and  $p_c$  would vary with weapon type.

The  $p_a$ ,  $p_b$ , and  $p_c$  can be broadly interpreted as the probability that a designated weapon will result in target destruction. Thus, depending on the particular application, the  $p_a$ ,  $p_b$ , and  $p_c$  could incorporate such factors as reliability, availability, pre-launch survivability, defense penetration capability, etc.

In the preceding discussion of EW an implicit assumption is made that the target complex consists of discrete point targets (targets small relative to the lethal coverage of the weapon) for which "probability of destruction" has a well-defined significance. If the target complex under consideration includes "area targets," i.e. targets whose value

is distributed over areas large compared to a single weapon's coverage, then a modification in the EW formula is required. In the implementation adopted here, type A targets are taken as soft points, such as radar installations, unprotected communication centers, etc. Type B targets are soft areas, such as military bases or staging locations. Type C targets are hard points, such as command centers, some industrial locations, dams, etc. Any current nuclear weapon has the yield and delivery accuracy to develop a near unity kill-probability for soft point targets (type A). The equivalent megatons (EMT) index provides a measure of area target (type B) kills referenced to a 1.0 megaton weapon<sup>(\*)</sup>. Kill probability for hard targets is expressed (approximated) by a well-known formula. Thus:

$$p_a = 1.0, p_b = Y^{2/3}, p_c = 1 - 0.5 \text{ CMP}/(H/16)^{2/3}$$

where: Y = weapon yield in megatons

$$\text{CMP} = Y^{2/3}/(\text{CEP})^2,$$

CEP = circle of equal probability (radius of)

H = target hardness (taken as 500 psi in calculations for this study)

The calculation of EW for a single weapon now becomes:

$$\text{EW} = \frac{1}{f_a + f_b/Y^{2/3} + f_c/p_c}$$

Returning to the first example with some additional information:

$$f_a = .45, f_b = .30, f_c = .25$$

Assume: Y = .5, CEP = .15, H = 500

(\*)

In determining the percentage distribution by target type the areas are considered to consist of as many separate targets as the number of 1 MT coverage circles required to suitably cover the areas.

[REDACTED]

Then:  $y^{2/3} = .63$

$$CMP = .63/.15^2 = 28.0$$

$$p_c = 1 - .5^{28/(500/16)^{2/3}} = .86$$

$$EW = \frac{1}{.45 + .3/.63 + .25/.86} = .82$$

Five hundred of these weapons are equivalent to  $500(.82) = 410$  perfect weapons.

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